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THE LARGE BRAIN, THE WIDE PELVIC GIRDLE AND THE OUTSTANDING NUMBER OF HIP ANOMALIES IN MAN

(Coxa Vara, Coxa Fracta, Coxa Plana, Coxa Valga, Slipping Epiphysis, Malum Coxae)

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INTRODUCTION

Since the year 1913 we have been teaching our pupils that coxa plana is regularly attended by a flattened hip socket, being in fact caused by it. In 1918, during the Great War, at a meeting of surgeons and orthopaedists in England, under the presidency of Sir Robert Jones, we expressed this view, illustrating it with the aid of drawings. Since then numerous observations have confirmed our view. Moreover, we have learned that a number of other affections of the hip joint may be caused by flatness of the hip socket and we have tried in a number of articles to trace the causes leading to the development of each of these changes. It seems that these have not always been sufficiently clear,—Ingelrans speaks of them as *"touffue et difficile à suivre"*. Nor have they failed to raise opposition. For these reasons we have tried in the present treatise to set forth our views in a less compact and more easily understood way, and with the help of much new evidence.

The first chapter comprises our hypothesis that a flattened hip socket is the cause of the hip affections mentioned above; the second, the deductions made from this hypothesis; the third, a comparison of our deductions with the facts; while the fourth chapter contains the criticisms of other writers; and the fifth, our criticism of them. Hence this treatise is composed of five parts:

I. *Our Hypothesis and our Reasons for it.*

A. The wide pelvic girdle of the human foetus is liable to lead to a flattening and a widening of the hip socket.

B. The flattened socket alters the stresses in the femoral head and neck.

II. *Deductions from our Hypothesis.*

The effect of the altered stresses in a flattened hip socket on head and neck of the femur depends on:

A. The degree of softening of the skeletal structures involved.

B. The intensity of the acting forces.

III. *Facts Illustrating and Confirming the above Views:*

A. Pathological changes in the head of the femur in cases of coxa plana.

B. Roentgenograms.

(1) Coincidence of coxa vara (fracta) and coxa plana in cases with flattened hip sockets (Figs. 40–43).

(2) Coincidence of coxa plana and coxa valga in cases with flattened hip sockets (Figs. 44–46).

(3) Coincidence of coxa valga and slipping epiphysis in cases with flattened hip sockets (Figs. 48–53).

(4) Malum coxae in flattened hip socket (Figs. 54–56).

IV. *Criticism from Other Observers.*

V. *Criticism of Others.*

I. OUR HYPOTHESIS AND OUR REASONS FOR IT

A. The wide pelvic girdle of the human foetus is liable to lead to a flattening and a widening of the hip socket.

Congenital dislocation occurs more often in the hip joint than in all the other joints of the human body taken together. In some parts of the world having a white population, three cases of congenital dislocation of the hip occur to every 1,000 births. Whereas a medical practitioner may not come across a congenital dislocation of the shoulder once in the course of a long practice, every lay person is familiar with the characteristic waddling gait of a congenital hip dislocation. The hip socket, however, is much deeper than the shoulder socket and the muscle masses surrounding the hip are much stronger than those around the shoulder.

Moreover, the non-dislocated hip joint in man is the seat of a larger number of affections than any other joint, apart from inflammatory conditions,—which are characterized by reflex stiffness, fever, and ill health—and from those changes which are brought about by the action of external forces. Inflammations and traumata do occur in the other joints as often as in the hip joint. We are only considering those conditions in which the general health is perfect and where rise of temperature, as well as reflex stiffness, is absolutely absent,—cases in which pain or a limp leads the patient to ask medical advice. They occur in such great variety that a suitable name has not yet been given to each one of them. The chief of

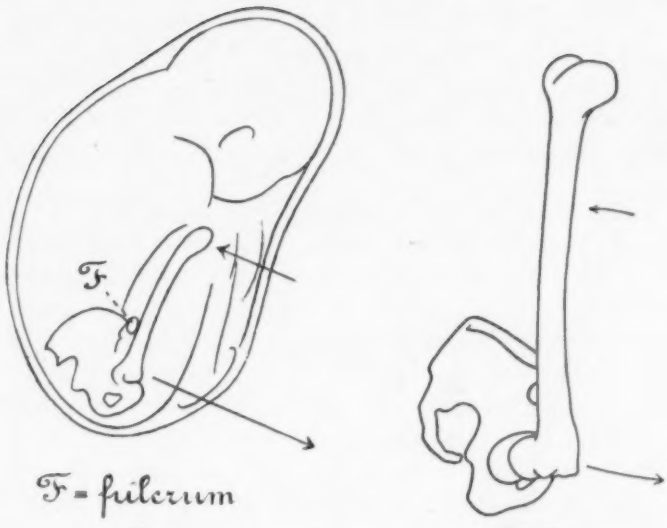


FIG. 1 FIG. 2

Figs. 1 and 2. Enhanced pressure from the foetal envelopes may lever the femoral head out of the hip socket, the wide pelvic girdle acting as a fulcrum. A thick socket floor,—*i.e.*, a flat hip socket, subluxatio or luxatio coxae—ensues and anteversion of the femoral neck.

these conditions are coxa vara, coxa fracta, coxa plana, coxa valga, slipping epiphysis, and malum coxae. In between these there are all kinds of transitional forms. We shall, however, limit ourselves to the study of the typical conditions just named. They show certain relationships with each other,—*viz.*:

(1) Very often two of them coincide in the same individual, as, for example, coxa vara and coxa plana, coxa plana and coxa valga, coxa valga and slipping epiphysis, coxa valga and malum coxae (See Figures 40 and 56);

(2) They often alternate in the various members of one and the same family,—*e.g.*, a mother with malum coxae often has a son with coxa plana.

These conditions also show a relationship to congenital hip dislocation, —in cases with single congenital hip dislocation, one of the above mentioned affections is almost regularly found on the other, non-dislocated side[1]. Also, after reduction of a congenital hip dislocation, one of the above mentioned affections often develops later on in the reduced joint.

Moreover, these conditions often alternate with congenital hip dislocation in the various members of the same family. A number of cases have been observed where one of the parents had congenital hip dislocation and one of the children coxa vara, coxa plana, coxa valga, or slipping epiphysis, or reversely. The same holds true of grandparents, uncles, aunts, nephews and nieces, or cousins. The frequency of the coincidence of these affections in the same individual and in the same family is so great that it is in itself a proof that coxa vara, coxa fracta, coxa plana, coxa valga, slipping epiphysis,

and malum coxae are closely allied to each other and to congenital hip dislocation. All these hip affections are the little-to-be-envied and exclusive inheritance of man. And we intend to adduce grounds for the assumption that they are all primarily caused by the extreme development of the brain in man, which necessitates a wide pelvic girdle in order to secure normal birth.

In a study which has not been sufficiently appreciated, Le Damany[2] has ingeniously brought forward the conclusive proof that congenital hip dislocation is due to limitation of the space available for the foetus in utero. For the complete argument we must refer to this study itself; we will restrict ourselves to the following quotation: "Even in the foetal state man differs from the animals through the large circumference of the pelvis. When pressure is exerted against the knees of the foetus, while the hip joint is flexed, the wide pelvic girdle in the region of the anterior superior spine offers to the femur a fulcrum more easily in man than in the animals, so that the head of the femur is levered out of the hip socket (Figs. 1 and 2).

"The floor of the socket, which is not any longer acted upon by the pressure of the femoral head, remains too thick[3]; the socket itself consequently becomes too shallow*; and in the most serious cases, dislocation of the hip ensues†. Even normally the wide pelvic girdle is the cause of an increasing shallowness of the hip socket during the last three months of prenatal life. After birth, however, it becomes deeper again. During the first six months of prenatal life, the socket resembles a half globe, and during the last three months it diminishes in depth from 0.5 to 0.4 times the diameter of the socket. Hence, congenital hip dislocation is simply an accentuation of a phenomenon which occurs normally in the development of every human foetus. It occurs when the coverings of the foetus are smaller than they should be. Then the thigh is flexed in the hip and the femoral head is levered out of its socket more forcibly than in the normal condition, the wide pelvic girdle offering a fulcrum. In this mechanical action the length of the human femur, which exceeds that of animals, plays a part, enabling the lever action to take place with relatively great force. The fact that the female foetus has a wider pelvic girdle than the male is in accordance with the fact that women are more often affected by congenital hip dislocation than men; and the reason why . . . the animals are exempt from congenital hip dislocation is found in the fact that they have a smaller brain, a comparatively smaller head and a relatively narrow pelvic girdle." (So far Le Damany.)

Congenital hip dislocation is the most serious result that the above mentioned lever action can have on the hip joint, and it may be *a priori* taken for granted that transitions between congenital hip dislocation and a

*For example, see Figure 9, in which there is a reduced congenital dislocation on the right side.

†"For the sake of simplicity we shall not discuss the anteversio colli femoris which develops in these cases. It will be dealt with later on in connection with coxa valga and slipping epiphysis."

normal hip joint occur much more often than congenital dislocation itself. An increased pressure may act either for too short a time or with too little power to cause hip dislocation, and yet be great enough or act long enough to cause the depth of the hip socket to decrease below the normal. Hence, while in cases of congenital hip dislocation we always find an abnormally thick socket floor, we shall expect to find a still larger number of cases where the thickening of the floor is present but luxatio coxae has not taken place. This condition is well known as subluxatio coxae. In it the floor of the hip socket is too thick and the socket itself too shallow. In the x-ray photograph the socket curve appears to be more widely extended than in normal cases. The curve of the socket having a larger radius than that of the femoral head, the socket does not fit around the femoral head, as it should, but deviates from the femoral head—as long as the head is normally formed—in its inner or mesial lower half. In the x-ray plate an open wedge-shaped space is seen between the femoral head and the lower inner (ischio-pubic) part of the hip socket, even when the exposure of the pelvis to the x-rays has been perfectly symmetrical (Compare Figure 4 with the normal Figure 3).

In these hip affections there is not always a flattening of the socket through a thickening of its floor. In a relatively large number of cases the floor of the socket is of normal thickness; but the os ischii has swung on a

FIG. 3
Normal hip socket.

FIG. 4
Flattened hip socket
(too thick socket floor).

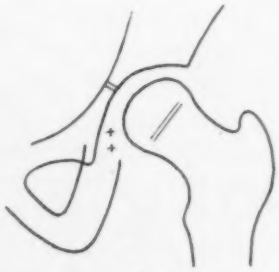


FIG. 5
Wide hip socket
(ischium varum).

FIG. 6
V-shaped pear-figure.

Note gap between femoral head and mesial part of socket line in Figs. 4, 5, and 6.

turning point situated about the middle of the acetabulum, so that its lower part points inwards. The foramen obturatum has thus become smaller on that side than on the normal side, so that at first sight one is inclined to ascribe the difference to asymmetrical exposure. However, when ischium varum is present, this difference is found even when the parts have been exposed with perfect symmetry. The socket curve appears to be too widely extended. The ischiopubic part of the socket runs too far inwards, and so deviates from the femoral head in so far as the latter has preserved its normal form. Hence, in cases of ischium varum the same wedge-shaped gap is observed between femoral head and hip socket that we observed in cases with a thick socket floor (Compare Figure 5 with the normal of Figure 3 and Figure 44, right side); but the femoral head does not necessarily stand too laterally, as is the case in thickened socket floor,—*i.e.*, in flattened hip socket. Therefore, it is not admissible to term a case with widened socket (through ischium varum) a subluxation of the hip, although, as may become patent from the following pages, flattened and widened socket essentially have the same effect on the femoral head and neck. For the sake of simplicity, however, we shall often speak of a "flat socket" in both cases.

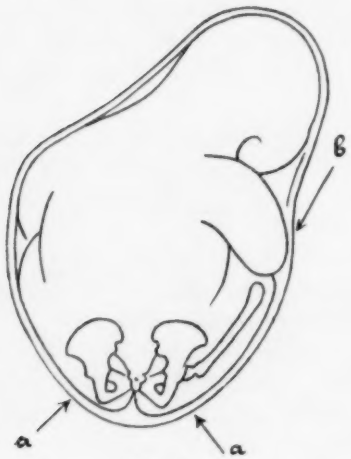


FIG. 7

Whether or not ischium varum may be sometimes caused by direct pressure of the too tightly stretched foetal membranes against the ischia (Fig. 7*a*)—against both when the foetus lies symmetrically, or against one ischium when the pelvis is rotated round an anteroposterior axis—we shall not discuss here. In any case, it is certain that the thigh of the foetus may be acted upon not only by

Figs. 7 and 8. Enhanced pressure from the foetal envelopes, acting in the line of the femoral axis, may press the femoral head against the lower part of the socket floor, and cause ischium varum, —*i.e.*, a wide hip socket, or also a V-shaped pear-figure, often attended by coxa vara congenita.

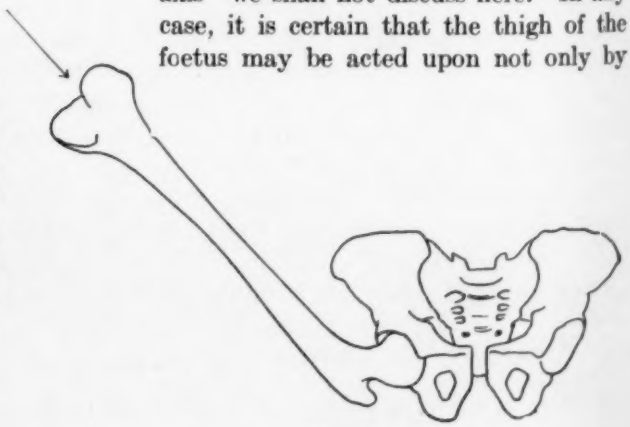


FIG. 8

pressure exerted in a direction at right angles to its axis, but also by pressure exerted in the line of its axis.

The wide pelvic girdle of the foetus opens up the latter possibility, since it favors a relatively extensive abduction of the thigh bones, a pelvic posture which might be compared with that of a tailor, as he sits at his work.

Hence, where there has been retarded growth of the foetal envelopes, the femoral head may be pressed too forcibly against the ischiopubic part of the hip socket by pressure of the too tightly stretched foetal envelopes on the flexed knee, hence through the line of the axis of the femur (Fig. 7*b* and Fig. 8). In cases where the pubic part of the socket line converges below with the mesial edge of the os ischii,—in other words where the U-shaped figure is pointed underneath, becoming V-like in form (as shown in Figure 6; also in Figure 43, right side)—and where the lower edge of the socket runs more widely extended than corresponds with the varus position of the ischium, it seems only reasonable to believe that pressure exerted along the axis of the femur has caused the V-form of what should be a U-figure, and so caused a widening of the hip socket. This assumption seems all the more justified in the relatively frequent cases in which ischium varum—either with or without a V-shaped U-figure—is associated with coxa vara on the same side. We are here referring to the characteristic clinical picture of ischium varum associated with coxa vara, or coxa fracta, while all the rest of the skeleton is strong, and free from deforming bends or curves.

In cases where only the U-figure is pressed in,—*i.e.*, V-shaped—and neither ischium varum nor coxa vara is present, the same pressure may have acted, though less strongly (See Figure 41, left) or on firmer material.

We have reasons for believing that the hip socket may not only become flat and wide, but also twisted. In the radiographs, where ischium varum is present, the ischial and the pubic parts of the socket do not always appear to be mesially displaced over an equal area. The twisted socket may develop when the pressure, acting along the femur, is directed more against the ischial than against the pubic part of the socket, or reversely, this being dependent on the greater or lesser degree of abduction and flexion of the femur at the time the pressure against the knee was being exerted. We shall not study the effect of twisted hip socket, since we have no evidence of its influence on femoral head and neck. Indeed, as long as both the ischial and the pubic parts of the hip socket are beyond the reach of the femoral head and the influence on the head of an existing torsion of the socket is limited to its iliac part, this influence may in all probability be identical with that of flattened or widened socket and thus be practically neglected.

Thick socket floor and ischium varum, or either of them, combined with a pointed pear-figure, often occur together in the same joint, or in the same

subject on different sides. It is even a rule that if the hip socket on one side is too flat or too wide, that on the other side of the same subject shows flatness or wideness too. Moreover, ischium varum, just as a thick socket floor and a V-shaped pear-figure*, is often combined with congenital hip dislocation in the same subject or in the same family. In short, congenital hip dislocation is often found combined with a flat hip socket (through a thick socket floor) or with a wide socket (through ischium varum or a V-shaped pear-figure), just as it is often combined with coxa vara, coxa fracta, coxa plana, coxa valga, slipping epiphysis, and malum coxae. It is the object of this paper to show that a *too flat* or a *too wide* hip socket must be looked upon as the cause of the above mentioned changes, and further that the extreme development of the human brain necessitating a wide pelvic girdle, through which the head has to pass at birth, must be looked upon as the primary cause of all these hip anomalies.

Congenital dislocation of the hip alternates in the same family not only with the above mentioned hip affections but also with other congenital abnormalities,—such as club-foot, hare-lip, congenital wry-neck, and other conditions which we will not enumerate. We will only mention rachischisis, since Lagrot found thirty-six cases of rachischisis among sixty-one cases of congenital hip dislocation, which led Lannelongue and J. Guerin to assume that congenital dislocation of the hip is caused by some abnormality in the central nervous system. We have grounds for assuming that rachischisis, just as congenital dislocation of the hip, may be caused by pressure of the foetal coverings on the foetus, but in a much earlier period of foetal life,—*viz.*, in about the third week; and that the frequent coincidence of spina bifida and congenital dislocation of the hip cannot be considered as evidence justifying the assumption that any one of these changes is due to primary changes in the nervous system.†

As has been said already, the female pelvis is wider than the male even in foetal life. Hence, under the same space limitation in utero, the changes which develop in the hip sockets of the female foetus will necessarily be greater than in those of the male. Therefore, the fact that congenital dislocation of the hip occurs more often in girls, whereas the less serious changes such as coxa vara, coxa fracta, coxa plana, coxa valga, malum coxae are more frequent in boys, is in perfect harmony with our views, and not, as Delchef[4] maintains, in opposition to them.

*The term pear-figure has been used throughout as most accurately designating the shape which the author wishes to describe. The meaning intended is that described in the German as *Tränenfigur*, literally "tear-figure". The connotation in English seems more clearly indicated by the term pear-figure.

†We may refer to our book "Feebleness of Growth and Congenital Dwarfism", Oxford Medical Publications, London, 1921, for the grounds for our views; also to our article "Faiblesse de Croissance et Nanisme congénital" in the Revue française de Pédiatrie, Vol. I, Nos. 5 and 6, pages 529 and 657, 1925–26, which is an improved and extended translation of the former; also to our article "Das Gesetz der Verletzbarkeit schnell wachsender Zellen" (The Law of the Vulnerability of Fast Growing Cell Groups), Zeitschrift für orthopädische Chirurgie, L, Heft 2, 193,1928.

FIG. 9

It is not necessary to accept the above views in order to form an understanding of the effect of a flattened or widened hip socket on the femoral head and neck. But it is necessary to know that the above mentioned forms of flattened and widened hip socket occur. For this reason we have given an illustration of a flattened hip socket on the right side in Figure 9. It is a reduced congenital hip dislocation. The distance between the center of the socket curve and the inner pelvic wall line is too large,—larger than on the left side. In other words, the strip of cartilage which here, as in all children, joins the socket curve to the inner wall of the pelvis—it lies in the center of the Y-shaped figure—is too long in this case. The socket roof shows irregularities,—a fact which we cannot study further here. On both sides there is coxa valga and on the right side coxa plana incipiens as well.

Figure 10 shows a thick socket floor and coxa valga on both sides. Figure 11 shows a too wide socket on the right side (there is ischium varum and a V-shaped pear-figure) with coxa plana. On the left side there is coxa vara. Whether or not the pear-figure deviates inwards on this side and the socket is too wide in its lower part, we shall not discuss here. We will emphasize the fact that coxa vara may occur in a normal hip

FIG. 10

FIG. 11

socket as is the case in rickets,—*i.e.*, severe feebleness of growth. Our argument, therefore, is that wherever flattened hip socket coincides with severe feebleness of growth (rickets) the former only enhances the degree of coxa vara which will result. The right ischium of Figure 11 runs obliquely from above downwards and inwards, so that the foramen obturatum seems too small on that side, in spite of the symmetry of exposure. In all these cases there are abnormalities in the femoral head and neck. We shall not discuss these at present. It may suffice to keep in mind that in case of thickened socket floor and of ischium varum the socket line is too widely extended; it is an arch drawn with too great a radius so that it does not fit around the normal femoral head. We refer to Figure 43, right, for the V-shaped pear-figure. Figures 50, 51, and 53 show another variety of the pear-figure, which might be called a notched or indented pear-figure. In Figure 52 the right side shows a narrowed U-figure.

Figures 4, 5, and 6 show the relationship between a flat and a wide socket schematically. Crosses have been drawn in these figures in the gap which exists between the bony parts of the femoral head and the hip socket before the deformation of the head has taken place.

Sometimes the stretched course of the socket line is accentuated,—*viz.*, when the socket roof does not run horizontally as it does normally, but upwards and outwards. The socket then acquires the form of a half lemon instead of that of a half orange (comparison made by Calot). The socket roof runs steepest in cases where the displaced femoral head has dug a new socket in the ilium just above the original one for the displaced head of the femur; and less steep in cases where the lateral portion of the socket roof has been pressed away by the subluxated femoral head (*cotyle à double étage*, Calot). Hence, both a flat socket with a shelving roof and a flat socket with an intact roof have a close relationship to congenital hip dislocation. They will be treated separately. In the following pages, unless the shelving socket roof be specially mentioned, the term flattened hip socket will be used to indicate either too wide or too shallow a socket with an intact socket roof.

Attention should be drawn to a difference which the position of the femoral neck regularly shows in flattened and in widened hip socket. In congenital dislocation of the hip, anteversion of the femoral neck, as is well known, is a constant phenomenon. In agreement with Le Damany's views, we assume that hip dislocation is caused by the femoral head being levered out of its socket. Therefore, in subluxation of the hip,—*i.e.*, in flattened or shallow socket (caused by a too thick socket floor)—anteversion of the femoral neck is likewise to be expected, although in a lesser degree. During the levering action in utero, indeed, the femoral head is—though less forcibly—drawn to the socket by the ligaments, while the trochanteric end of the neck is drawn away from it. In the causation of ischium varum, however, neither the lever action nor the ensuing twisting forces comes into play. Here, however, the pressure, in so far as it acts in the direction of the

femoral axis, tends to bend the femoral neck into a varus position, at the same time producing the widening of the hip socket,—*i.e.*, the varus position of the os ischii. Hence, in flattened hip socket (thick socket floor) anteversion of the femoral neck is to be expected, and in widened hip socket (ischium varum) congenital coxa vara is the more frequent corollary. In Chapter II we shall discuss the influence which anteversion of the femoral neck in flattened hip socket must be considered to have on the distribution of the acting forces; and in Chapter III we shall test our conclusions by the facts.

It may be that the reader tends to start from the supposition that the abnormalities of the hip socket, of which we have given illustrations, are never primary but always and exclusively secondary to primary changes in femoral head and neck. If such an one could bring forward conclusive proof for this assumption, then every word about the effect of flattened hip socket on the normal femoral head would indeed be wasted. But in the following pages we shall see that different authors have tried in vain to furnish such proof, and moreover that the numerous changes of femoral head and neck in flattened hip socket would become perfectly enigmatic on such an assumption. But even if it could be shown that in some cases these phenomena did arise from sources other than mechanical, the intricate problem of hip anomalies might be considered to have met with exhaustive treatment only after the consequences of too shallow or too wide a socket had been fully traced. We, therefore, feel entitled in the following pages to build on the hypothesis that flattened hip socket is the primary anomaly in the various phenomena which we have enumerated.

Thus we shall first have to study the way in which flattened (or shallow) hip socket modifies *the forces* acting on the femoral head and neck. In the second place we shall have to consider *the laws* according to which bone of various degrees of feebleness of growth must be expected to react to the altered stresses. And in the third place we shall have to submit our deductions to the test of *facts* and supplement them with the same.

With regard to the period of foetal life in which flattened hip socket usually develops, it should be noted that some of our patients with flattened hip socket unmistakably have too short extremities. In these cases it is evident that the increased amniotic pressure was present before the union of amnion and chorion in the fourth month of pregnancy,—that is, at a time when the blood could escape into the placenta under the influence of enhanced hydrostatic pressure in the amniotic sac. It is equally evident that in cases where flattened hip socket is found together with extremities of normal length, the increased pressure arose only after the fourth month of pregnancy[5].

B. Flattened (wide) hip socket alters the stresses in the normally formed femoral head and neck.

While the normal hip socket is in contact with the femoral head over the whole of its surface, the flattened hip socket comes only partly into

contact with the same (See Figures 4, 5, 6, 9, 10, and 11),—*i.e.*, as long as the femoral head itself is normally formed. A condition arises which is roughly comparable to the relationship between a cup and a saucer. Thus in standing and walking only the upper part of the femoral head comes into contact with the roof of the socket. Hence the forces, which come into play and which are normally transmitted through the whole surface of the socket to the inner as well as to the upper surface of the femoral head or vice versa, are concentrated on the small area of contact between femoral head and socket roof in cases of flattened hip socket. Normally, the turning point, around which all movement takes place in the hip socket, is the center of the femoral head,—this point remaining practically stationary in its relationship to the socket. In flattened hip socket the turning point has shifted to the area of contact between the femoral head and the socket roof, where, moreover, friction may be evoked. Whereas normally the forces acting during the movements of the hip joint press the head as a whole more forcibly against the whole of the socket surface*, in flat hip socket the head is pressed against the socket only over the small area of contact with the socket. If we consider the acting forces severally,—those running through the area of contact, those mesial, and those lateral to it,—it is clear that the first mentioned can only press the head more firmly against the socket and also displace it inwards, but the two groups of forces acting mesially and laterally to the area of contact can also cause the head of the femur to rotate. Those forces acting mesially to the area of contact tend to rotate the head so that its inner side faces upwards; those acting laterally tend to rotate it so that the outer side faces upwards. If, for example, in Figure 12, B is the point of contact between the femoral head and its socket, and AP the resultant of the forces which are acting mesially to the area of contact, then $AP \times BC$ is the moment with which the force AP draws the parts of the head and neck lying mesial to point B upwards and inwards, and in doing so tends to deform them both.

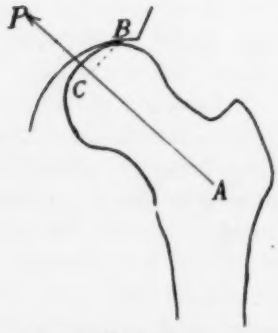


FIG. 12

In flattened (and widened) hip socket, muscle action develops a couple of forces $PA \times BC$ which tends to rotate femoral head and neck, mesial side upward.

In a normal socket the movements of abduction and adduction while walking are relatively small. Hence the resultant of the acting forces during walking runs through or close to the turning point,—that is, the center of the femoral head. In consideration of this fact, we have drawn AP through the center of the femoral head. Moreover, AP is drawn parallel to, hence in the axis of, the femoral neck, because there are reasons for assuming that the resultant of forces acting during walking and standing normally runs through this line. However, this does not concern us here.

*For the sake of simplicity we will not discuss the fossa acetabuli.

The forces which act laterally to the point of contact B evoke a couple of forces, opposite to $AB \times BC$. In flattened hip socket these forces may be even greater than normal. Displacement of the normal turning point in the center of the femoral head to point B, indeed, increases the tendency to adduction. And when this increased inclination is counteracted by muscular action lateral to B, and not by a swinging of the trunk to the side, the above mentioned forces are greater than normal, inasmuch as they prevent the pelvis from dropping on the other side (*i.e.*, from Trendelenburg's phenomenon), while the leg on that side is being slung forwards.

As soon as the split lateral to B disappears—either because of abduction or by a change in the form of socket or femoral head—the couple of forces cannot any longer draw the lateral part of the femoral head and growth disc upwards. *Mutatis mutandis* the same holds true for the upward rotation of the mesial parts of femoral neck and head by the mesial couple of forces $AP \times BC$. A number of cases have been observed in which the socket roof runs upwards, so that the split mesial to B and the split lateral to it are equally large; and in other cases where the socket roof runs still more vertically upwards, the lateral split is even larger than the mesial one. We shall speak of these later on. In cases of flat socket with an intact roof (as in Figure 12), the mesial split is much larger than the lateral one, because the point of contact B is on the lateral side of the femoral head. And this may be one of the reasons why in flattened hip socket with an intact roof, only the deforming effect of the couple of forces $AP \times BC$ (See Figure 12) is noticeable on the femoral head and neck, both showing a tendency to rotate so that the mesial side faces upwards, the lateral side downwards. Figures 44 and 45 give an example of this. On the right side there is a flat hip socket by reason of a too thick socket floor. In it the femoral neck has been raised into the valgus position in the course of four years' time. This is the first case where a raising of the femoral neck in cases of a flat socket has been observed, at least inasmuch as the difference in rotation of the femur on the two sides which the figure shows is not enough to account for the difference in the position of its neck.

On the left side of this figure coxa plana has developed. We shall discuss this later on. For the present it may suffice that two rules become manifest in these figures, the validity of which we shall often have occasion to verify:

(1) *If a hip socket is evidently flattened (wide), the other one is also flat, although often to a lesser degree.*

(2) *The femoral head shows the greater changes in the flatter socket.*

In cases where the socket roof is deficient,—*i.e.*, when the iliac part of the socket slopes upwards, the point of contact B between the femoral head and the socket is displaced inwards. If the upward incline is enough to cause the point of contact to coincide with the end of the axis of the femoral neck, the split on either side of this point of contact is equally large. Then the forces acting on the inner side of the femoral head and neck appear not to be greater than those acting on the outer side. Perkins has given an

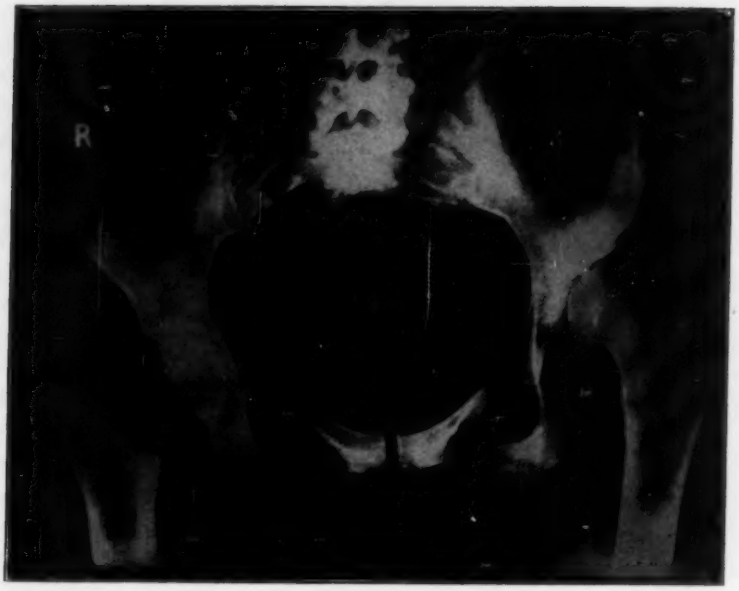


FIG. 13
Perkins' case.

illustration of such a case, in the belief that the absence of coxa plana here is contrary to our views. He calls the femoral head in that case "well formed". The radiograph given in Figure 13 has been generously lent to the author by Mr. Perkins, and in Figure 14 we reproduce a tracing made of the figure of it given in his criticism of our views[6]. Far from being in contradiction to our views, this case is a striking confirmation of them. The femoral head shows a flattening and broadening, which proves that here too pressure concentrated on a small area could not be borne without resulting in deformation. And the direction in which the flattening has taken place is in undeniable agreement with that of the acting forces. If the socket line runs still more vertically upwards than it does in Figures 13 and 14, the point of contact between the femoral head and its socket is situated still more mesially, and the inner side of the head and growth disc show tendency to drop with regard to the outer; or, inversely, the outer side shows a

FIG. 14
Perkins' case.

When the hip socket is flattened to such a degree that the area of contact with the femoral head is in the axis of the femoral neck, there is no rotation of the head, but symmetrical flattening and widening of head and neck.

tendency to rise higher than the mesial side (See Figure 15, left, and Figure 16, right).

Hence, in cases where the point of contact is situated mesial to the axis of the femoral neck, the couple of forces is opposite to that in Figures 9, 10, 11, and 12, where the point of contact is lateral to this axis. In Figures 15 and 16 the rotating moment is weakened by the fact that the socket curve runs steeply upwards, which allows of considerable displacement at the expense of the effect of the couple of forces. Nevertheless, in these cases where the point of contact is situated mesially, an absolute or relative lowering of the mesial part of the femoral head is unmistakable.

It should be observed what serious flattening the femoral head may sustain through abnormal mesial pressure from the steep socket. A study of the various changes of femoral head and neck in hip sockets of different form thus furnishes arguments for the assumption that the resultant of the forces acting upon neck and head passes through the axis of the femoral neck, and consequently an upward rotation of the internal part of the head is to be expected when the point of contact is mesial to this axis, as is the case in flattened hip socket with normal roof.

In agreement with this, in the other,—*i.e.*, the right side in Figure 15, also with flattened hip socket but with a roof which is better preserved than the left—there is slight valgus position of the femoral neck, flattening of the head, a too horizontal position of the growth disc. Figure 16 shows the same phenomena on the left side, though less marked.

In what follows, we shall first deal with cases with an intact socket roof, the point of contact thus being situated laterally, while a couple of forces mesial to it tends to rotate the femoral head and neck with the inner side upwards and outer side downwards.

In Figure 17 we have made a diagrammatic sketch of such a case. Besides the above mentioned force acting along AP, we have added two other equal but opposite forces acting along the lines QB and RB, meeting at B and acting along a line parallel to AP. They do not alter the mechanical balance; but it becomes evident that besides the couple of forces $AP \times BC$ which causes rotation of the head, another force BR is working

FIG. 15

FIG. 16

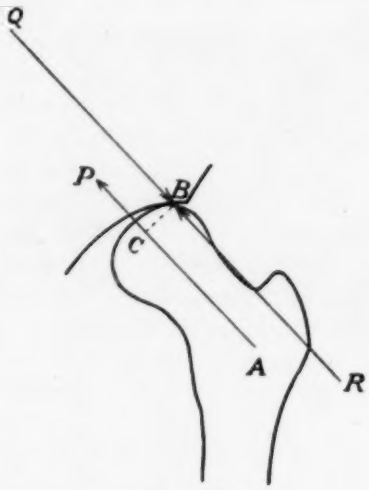


Diagram illustrating muscle action in flattened (widened) hip socket.

Besides a couple of forces $AP \times BC$ which tends to rotate the femoral head and neck, mesial side upward, a force BR tends to displace the femur mesially with an horizontal component, while a vertical component supports the force of gravity.

FIG. 17

through AP. This may be resolved into a horizontal and a vertical component. The horizontal force tends to shove the head inwards along the socket roof; the vertical force tends to push the head against the socket.

Summarizing, flattened hip socket (with intact roof) alters the mechanism of the muscle action in such a way that three groups of forces act on the head and neck of the femur:

(1) A couple of forces, mesial to the area of contact between socket and head, tends to rotate the inner side of the femoral head and neck upwards and the outer side downwards.

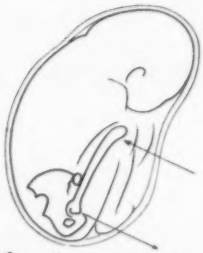
(2) Through a shoving force which tends to displace the head inwards, friction is evoked between head and socket. The shoving forces apply to the bone below the head—as do all the other muscular forces—in the region of the trochanters or still lower down. Hence the tendency of the shoving forces to displace the neck further inwards than the head,—*i.e.*, to displace *the head laterally with regard to the neck.*

(3) A force acting vertically through the limited area of contact between the femoral head and its socket.

Added to these forces the force of gravity is to be taken into account, which acts vertically downwards and also goes through the area of contact B.

In cases of flattened hip socket with an intact roof, the change of position of the turning point from the center of the femoral head to its surface and the mesial gap between the head and the socket,—apart from the shoving force—two groups of muscular forces are brought into action which are opposed to each other,—*viz.*, on the one hand, the couple of forces that tends to raise the femoral head and neck into the valgus position, and on the other hand, the vertical pressure of muscular forces which act along with the force of gravity and tend to push the head and neck downwards,—*i.e.*, to force the femoral neck into a varus position. (Plate 1 gives the chief points of this chapter collected in table form.)

The large brain, the wide pelvic girdle and the outstanding number of hip-anomalies in man.

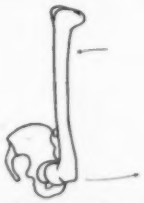


either levered out of the socket

or

pressed against its lower portion

The foetal envelopes being too small, the femur may be



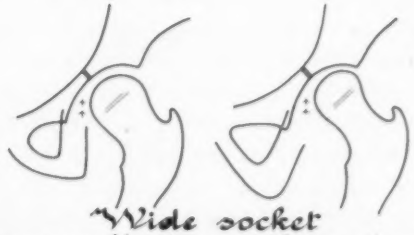
Flattening of the socket and even congenital dislocation

or

widening of the socket ensues.

normal socket (for comparison)

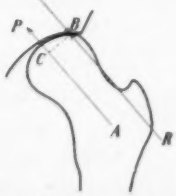
flat socket (thick socket-floor)



Wide socket (narrow U-figure) (ischium varum)

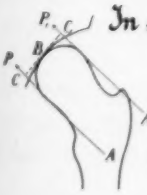
Rule: If the socket is flat or wide on one side, there is flattening or widening on the other side.

Flat (wide) hipsocket evokes abnormal stresses in the femoral head, viz:



1° couple of forces PA × BC;
2° horizontal component of BR;
3° vertical component of BR reinforcing power of gravity.

In shelving socket-roof B lies more mesially:



two couples may counterbalance each other,

or even

a lateral couple may predominate.

PLATE 1.

II. THE EFFECT OF THE ALTERED STRESSES ON THE FEMORAL HEAD AND NECK IN FLATTENED HIP SOCKET IS DEPENDENT ON:

A. The degree of enfeeblement of the skeleton;
B. The intensity of the stresses.

A. The Degree of Enfeeblement of the Skeleton.

The special property of bone tissue, and especially that of the supporting bones, is the power to develop, to maintain itself, and to grow against the pressure of muscles and the power of gravity[7]. Every practitioner knows that in most skeletons this vital power is predominant, but that in other cases, and especially in young children with rickets, this power is not equal to the forces acting on the bone. Hence it must be expected that in some cases of flattened socket the mesial couple of forces will aid the bone in its specific function and raise the femoral neck, whereas in other cases the perpendicular forces will prevail, and in still other cases the two groups of forces will balance each other.

However, there is more: the growing femoral neck is not a homogeneous body. There is a growth disc in it. The contiguous parts, considered from a purely mechanical point of view, in some cases offer equal, and in other cases less, resistance than the rest of the femoral neck and head. When equal, the angle which the growth disc forms with the neck remains normal. When less, the angle is altered. In the latter case the condition is roughly comparable to one in which the parts contiguous to the growth disc are replaced by soft material which allows itself to be compressed where the pressure stresses are greatest and to be distended where the tension stresses prevail, the head being thus slowly rotated in its relationship to the axis of the neck. In reality this rotation generally depends on a difference in the rapidity of growth, a phenomenon of which the developing knock-knee is a well known illustration, the lateral part of the growth discs near the knee growing less rapidly than the mesial. And in the following pages we shall see that the amount of this difference in growth is intimately connected with the degree to which the bone has been enfeebled.

In our study "Feebleness of Growth and Congenital Dwarfism"[8], we studied the symptoms of enfeeblement of the power of growth. They may be summarized under ten headings. We shall quote them here. (For the grounds on which they are based we must refer to the study just quoted.)

(1) The overgrown adolescent, the knock-knee child, the rachitic child, the athreptic, and the pedatrophic successively form an ascending series of degrees of feebleness of growth.

(2) Evidence of Rule I is obtained by a comparison between the various children born of the same parents, with regard to the harmful influences to which they have been exposed, this comparison being made in a large number of families.

(3) Feebleness of growth is brought about by every harmful influence affecting the (reproductive cells of the) parents or the child itself, before or after birth.

(4) The degree of feebleness of growth is proportional to the intensity of the harmful influence which causes it.

(5) The degree of feebleness of growth is proportional to the rapidity of growth (*our law of the vulnerability of fast growing cells*):

(*a*) *of the individual,* so that the severe degrees of feebleness of growth occur during the first years of life;

(*b*) *of the parts,* so that the muscles suffer first, then the skeleton, and in the skeleton first the growth discs.

(6) Feebleness of growth is characterized by enhanced irritability and enhanced fatigueability.

(7) In the slight degree the increased irritability predominates in the clinical picture,—so that the length of the individual exceeds the normal.

(8) In the severe cases (rickets) the fatigueability predominates, and the length growth of the individual lags behind the normal. At the same time the enhanced sensibility to pressure leads to deformations, because every difference in pressure causes a difference in the amount of growth.

(9) The retardation of skeletal growth in severe cases of feebleness of growth is associated with extra retardation of differentiation,—*i.e.*,

Diagrams showing three degrees of feebleness of growth (and a normal subject for comparison).

FIG. 18
The severe degree (the rachitic).

FIG. 19
The moderate degree (the knock-knee child).

FIG. 20
The slight degree (the overgrown).

FIG. 21
A normal subject.

differentiation in the skeleton behaves like a process of more rapid growth than cell-division and cell-enlargement.

(10) In the severest degrees of feebleness of growth (athrepsia, pedatrophy) the three stages of skeletal growth,—cell-division, cell-enlargement, and cell-differentiation—seem to be affected in inverse order: the third phase sooner and more intensively than the second, and the second sooner and more intensively than the first.

Thus three degrees of feebleness of growth have to be distinguished. A type of each is represented in the preceding figures together with a normal subject for comparison.

For the proper understanding of what follows it is not necessary to study the grounds for, and the mode of application of, the previous aphorisms and rules. In other words, it is not imperative that the reader should admit that Figures 18, 19 and 20 represent three successively decreasing degrees of feebleness of growth, and differ from the normal of Figure 21 only quantitatively. He may—if it should seem to him to be nearer the truth—even assume that they differ qualitatively. For our argument it suffices to realize that Figures 18, 19 and 20 represent three well defined types of frequent occurrence between which—it is true—there are numerous transitions, but the growth of each one of which reacts in a characteristic way to the pressure of muscles and gravity. It is necessary to realize also that those parts which grow fastest always show the greatest amount of deviation from normal growth.*

The bones of the *rachitic child* (Fig. 18) *bend under the influence of pressure. Moreover,* they remain too short,—*i.e.*, each growth disc lags behind normal growth. Moreover, the growth discs are so sensitive to any difference of pressure that *they grow less wheresoever pressure is greater,* thus forming too oblique angles with the diaphysial axis.

The bones of the *knock-knee child* (Fig. 19) do not bend under the influence of pressure. They neither grow too slowly nor too quickly. They are of normal size. The growth discs are far less sensitive to pressure, so that they form normal angles with the diaphyseal axis. Only *the growth discs which grow quickest* of all during the period of life in which knock-knees develop,—*viz.*, those near the knee joint,—show a decrease of growth on the side where pressure is greatest,—that is, on the outer side; these growth discs *show decrease of growth to increase of pressure.*

The bones of the *overgrown* (Fig. 20) not only withstand functional

*Besides the various degees of feebleness of growth, other conditions are known in which the firmness of structure of the bone is below the normal,—*viz.*, in osteogenesis imperfecta, in slighter cases known as osteopsathyrosis, often also in dysostosis cleidocranialis, furthermore osteomalacia and lastly hunger osteomalacia—either caused by an absolute shortage of, or a one-sided, diet,—such as we have found in orphanages. These conditions, however, are—fortunately at the present time even the last mentioned—rare in comparison with feebleness of growth, and their phenomena for the most part may be classed together with those of severe feebleness of growth, so that we may refrain from a separate discussion of them. Hence, although in every special case one or more of these conditions may play a part in decreasing the power of growth and the firmness of the bone, still feebleness of growth remains by far the most frequent cause of such decrease.

pressure without bending, but they even grow all the more quickly. The growth discs in these subjects are still less sensitive to a difference of pressure so that the most rapidly growing ones, those near the knee, will withstand an excess of pressure on the outer side without showing a decrease of growth on that side, unless the pressure *far exceeds the normal* (as in errand boys).

The bones of the *normal subject* (Fig. 21) do not bend, neither do they grow too slowly nor too quickly. The growth discs are so little sensitive to a difference of pressure that even the most rapidly growing ones do not react to an increase of pressure by a decrease of growth. The bones of the normal subject can withstand far more than normal pressure stresses without undergoing changes in form and growth.

Let us now suppose that the types represented in Figures 18, 19, 20, and 21 have all been born with a flat hip socket, and let us ask ourselves what will be the various results in them of the couple of forces $AP \times BC$ (Fig. 12) which—as we have tried to prove—is necessarily evoked by the existence of a mesial gap between femoral head and hip socket. It is quite clear that the growth disc in the upper femoral end will not in them all react in the same way to the action of increased pressure laterally and diminished pressure mesially. On the contrary we shall have to expect that the reaction will be about the same as that of the growth disc in the lower femoral end. As is well known, the rate of growth is less in the growth disc at the upper than in that at the lower femoral end; but on the other hand the possibility cannot be excluded that the increase of pressure on the lateral part caused by the couple of forces $AP \times BC$ (Fig. 12) of the upper growth disc is greater than is ever brought about on the lateral part of the lower growth disc of the femur by the pressure of muscles and gravity. In any case we must expect that in a flattened hip socket the upper femoral end will show differences in the rachitic child, in the knock-knee child, in the overgrown, and in the normal child. Moreover, these differences will show some resemblance to the behavior of the rest of the femur and the parts contiguous to the lower growth disc, as is stated in Table I.

TABLE I

IN FLATTENED (WIDE) HIP SOCKET

	With severe feebleness of growth (rickets)	With moderate feebleness of growth (the knock-knee child)	With slight feebleness of growth (the overgrown)	Of the normal subject
We are to expect	bending of femoral neck and much decreased growth laterally in the growth disc.	no bending of femoral neck, moderately decreased growth laterally in growth disc.	raising of femoral neck, slightly decreased growth laterally in growth disc.	no bending, no raising of femoral neck, no decreased growth laterally in growth disc.

The intensity of feebleness of growth being proportional to the rapidity of growth, and the rapidity of normal growth gradually decreasing after birth, the severe form of enfeebled growth is associated with the first years of life; the moderate and the slight degrees are restricted to the following years and to adolescence, respectively. In agreement with this, the severe changes must be expected in the young child before he begins to walk, about the second year; those of the knock-knee child develop during walking,—*i.e.*, in and after the second year; while the symptoms of overgrowth are met with in adolescence between the tenth and the sixteenth years.

TABLE II
IN FLAT (WIDE) HIP SOCKET

	With severe feebleness of growth (rickets)	With moderate feebleness of growth (the knock-knee child)	With slight feebleness of growth (the overgrown)	Of the normal subject
We are to expect	bending of femoral neck and much decreased growth laterally in the growth disc.	no bending of femoral neck, moderately decreased growth laterally in growth disc.	raising of femoral neck, slightly decreased growth laterally in growth disc.	no bending, no raising of femoral neck, no decreased growth laterally in growth disc.
	Before walking, —*i.e.*, in the first years of life.	After beginning of walking,—*i.e.*, after the first and second years.	During adolescence, about the fourteenth year.	

It is known that coxa vara, coxa plana, coxa valga, and malum coxae each have a characteristic age at which symptoms appear: coxa vara,—*i.e.*, the type with a bent femoral neck—as early as the first years of life; coxa plana between the third and the tenth years; coxa valga about the seventh to the fourteenth; slipping epiphysis about the tenth to the fourteenth; and joint wear in the hip (malum coxae) in later years, usually after maturity.

Summarizing, we may say:

TABLE III
THE DEVELOPMENT OF

	Coxa vara	Coxa plana	Coxa valga	Malum coxae
Coincides with	first to third years	third to tenth years	seventh to thirteenth years	after fourteenth year, mostly after maturity.

A comparison of the age at which the characteristic symptoms of the rachitic child and the overgrown occur, with that at which coxa vara, coxa plana, coxa valga, and malum coxae develop, thus yields a rough analogy. Hence, if it appears in what follows that our hypothesis is tenable,—*viz.*, that congenital flat hip socket is the cause of coxa vara, coxa plana, coxa valga, and malum coxae—then the incidence of these conditions successively at later periods of life furnishes a ground for the assumption that they require a successively increasing period of time for their development. In the analogy of the length of time needed for the development of these conditions with that required for those typical of rickets, knock-knees and overgrowth, we thus find a ground favoring the assumption that coxa vara, coxa plana, coxa valga, and malum coxae are bound to successively decreasing degrees of feebleness of growth, roughly corresponding to our three classes of severe, moderate, and slight feebleness of growth. Generally speaking, malum coxae then belongs to the normal individual, the more so the later it occurs.

It should be borne in mind that the degree of feebleness of growth determined for each of the above mentioned hip conditions is only a rough approximation. We have observed coxa vara both in severe cases of feebleness of growth (in rachitic patients) and in patients who did not even show knock-knees. In the latter case, indeed, prenatal pressure in the femoral length axis may have been at play, producing both coxa vara and ischium varum (See page 471); but the fact that often two different conditions are met with in the same individual clearly shows that it is not the degree of feebleness of growth alone which determines the nature of the changes of femoral head and neck in flattened hip socket. One and the same subject, indeed, can have only one degree of feebleness of growth on both sides. In order to form a proper judgment of these differences, the difference in intensity of the acting forces has to be considered, with which the following chapter will deal. That nevertheless the degree of feebleness of growth of the subject plays a part in the resulting condition becomes patent from the following facts: If we successively call coxa vara, coxa plana, coxa valga, and malum coxae 1, 2, 3, and 4, we find that 1 and 2, 2 and 3, 3 and 4 coincide more often in the same individual than, for example, 2 and 4. And in the following chapter we shall bring forward evidence favoring the assumption that the moderate degree of feebleness of growth tends most to the development of coxa plana in cases of flattened hip socket.

Plate 2 summarizes in table form the chief points of Chapter II *A*.

B. The Intensity of the Acting Forces.

This is dependent on:

(1) the position of the femoral neck,
(2) the position of the growth disc,
(3) the degree of flattening (widening) of the hip socket,
(4) body weight,
(5) traumata.

In flat hipsocket the effect of the altered stresses varies with

A. the degree of enfeeblement of the skeleton.
B. the intensity of the stresses.

A. The feebler the skeleton, the greater the changes and the more rapidly they develop (and reversely).

Flat (wide) hipsocket

	in the rickety the knock-knee child		the overgrown	the normal subject
causes	coxa vara	coxa plana initial / complete	coxa valga	osteo arthritis (malum coxae)
i.e.	bending and greatly decreased growth laterally in neck.	no bending but moderately decreased growth laterally.	rise of neck and slightly decreased growth laterally.	no bending, no rise, no decreased growth laterally.
age incidence	1st-5th year	3rd-10th year	7th-14th year	after 14th year often after middle age.
	1.	2.	3.	4.

Rule: Two successive conditions are apt to coincide in the same individual. For example 1 & 2, 2 & 3, 3 & 4.

Note the growth cartilage takes up a horizontal position only in coxa plana (initial stage), not in coxa vara and valga.

PLATE 2.

(1) The Position of the Femoral Neck.

In cases of flattened hip socket and a normal femoral neck, the bone elements on the convex side of the femoral neck largely escape the forces of pressure (See Figure 23). This is also the case in coxa vara (Fig. 22) in which, moreover, by reason of the increased bending of the neck, the convex-sided elements are more subjected to tension stresses than in the normal neck. In our study "On Boneformation" [7] we have tried to prove

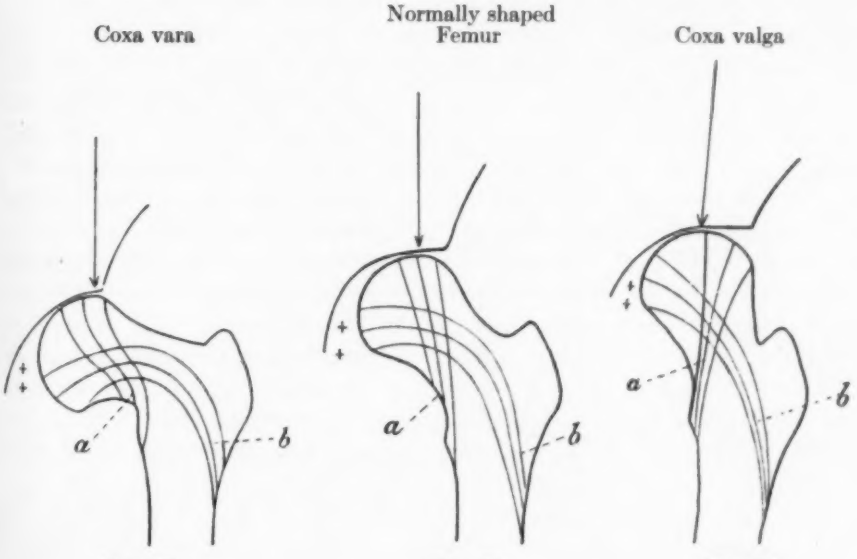


FIG. 22 FIG. 23 FIG. 24

In flattened (widened) hip socket the convex-sided bone elements in the femoral neck largely escape the forces of pressure in coxa vara and the normally shaped femur, much less so in coxa valga.

that tension stresses are not a stimulus to the formation of bone. Hence the increased tension to which the convex-sided bone elements in coxa vara are subjected must not be expected to lead to a thickening of them, but rather to a thinning and subsequently to a tendency to stretch. In addition to this, the position of the concave-sided bone elements is more unfavorable for the function of support than is normally the case. On account of these facts in primary coxa vara,—either a congenital or a rachitic coxa vara—flattened hip socket enhances the possibility for the varus position to increase, especially to sustain a fracture of the femoral neck.

The opposite holds good for coxa valga (Fig. 24) in which the convex-sided bone elements are not only subjected less than normally to tension stresses but also take their part in bearing the pressure stresses. A bending of the femoral neck in a varus position thus opens up a vicious circle for the neck with regard to the perpendicular forces; and this may be the reason why coxa vara in flattened (wide) hip socket tends to sustain a fracture of the neck, the head being displaced downwards in its relation to the

trochanters, a condition which we will call coxa fracta. A rising of the femoral neck into the valgus position, on the other hand, makes it more capable of withstanding the pressure caused by the force of gravity.

In relation to the couple of forces, the changes which coxa vara and coxa valga undergo are opposite, when considered to start from the normal condition. If we compare, for instance, Figure 25, coxa vara, and Figure 27, coxa valga, with the normal position of the femoral neck (Fig. 26) all in flattened hip sockets, it is clear that if the force AP is the same, the couple of forces $AP \times BC$ is greater than normal in coxa vara and less than normal in coxa valga. The cause of this lies in the fact that if the femoral neck bends, the point of contact B comes to lie more laterally on the femoral head than normally, and thus further from the femoral axis,—*i.e.*, BC becomes greater. On the other hand, when the femoral neck is raised, the point of contact B comes to lie more mesially on the femoral head than normally,—*i.e.*, BC becomes smaller than normal. *Ceteris paribus* the couple of forces will be greater than normal in coxa vara and less than normal in coxa

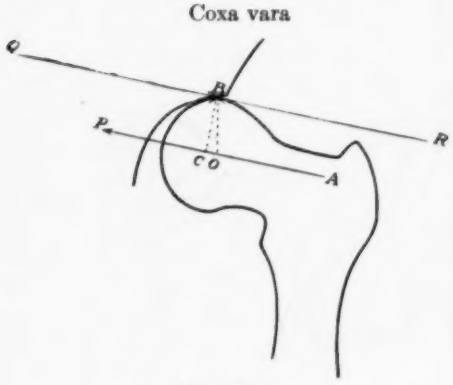


FIG. 25

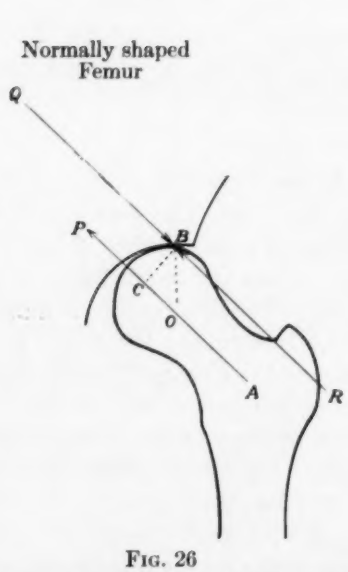


FIG. 26

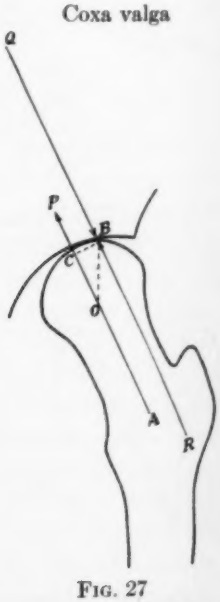


FIG. 27

The couple of forces $AP \times BC$ evoked in flattened (widened) hip socket is greater than normally in coxa vara, smaller in coxa valga.

The couple of forces $AP \times BC$ lessens itself, as it raises the femoral neck in the valgus position.

valga. Hence in the raising of the femoral neck the couple of forces $AP \times BC$ exhausts itself, and this may be the reason why a femoral neck never rises beyond the vertical position or indeed never reaches the vertical position. Both with regard to the perpendicular forces and with regard to the couple of forces, the rising of the femoral neck furnishes protection against further deformation of the femoral neck as a whole, and as regards the rotation of the growth disc and femoral head to the horizontal position.

Anteversion of the femoral neck occupies a separate place with regard to its effect on femoral neck and head. It is a phenomenon of constant occurrence in congenital dislocation of the hip, which—as has been said in the above—arises according to Le Damany from forced flexion of the foetal hip, through which the femoral head is levered out of its socket. It may therefore be assumed that anteversion of the femoral neck is also present in transitional stages between congenital hip dislocation and the normal, though in a less degree. With a skeletal pelvis and a femur, it is easy to ascertain that with the valgus position of the femoral neck the chance arises that it knocks against the posterior lateral border of the socket, especially in hyperextension of the leg,—*i.e.*, while walking,—*viz.*, at the moment when the leg acts as a support and is hyperextended. This chance is enhanced by the coincidence of anteversion of the neck. The remarkable tendency of the femoral head, which is especially observed in coxa valga, to displace backwards and downwards (slipping epiphysis) may thus find its cause in the upright and the anteverted position of the femoral neck. A levering of the femoral head anteriorly out of its socket, by a thrust of the neck against the posterior and lateral edge of the hip socket, repeatedly taking place at every step, thus seems to be the probable cause of slipping epiphysis. At least we know of no other facts in slipping epiphysis accounting both for the detachment of the femoral head and for its backward displacement and rotation.

(2) The Position of the Growth Disc.

We are now to examine the effect which the couple of forces brought into action in flattened hip socket must have on the position of the growth disc in severe, moderate, and slight feebleness of the skeleton, as compared with the normal.

In severe enfeeblement of the power of growth we have seen coxa vara developing in which the couple of forces $AP \times BC$ appeared to be great. This bone, moreover, easily reacts with decrease of growth on the side of increased pressure (in this case laterally). Hence on that side the growth disc comes to lie at oblique angles to the neck,—*viz.*, low down laterally.

In slight feebleness of growth on the other hand, in which coxa valga was seen to develop, the couple of forces $AP \times BC$ is small and the bone reacts far less easily with decrease of growth on the side of increased pressure,—*i.e.*, on the lateral side. Hence, here the growth disc must be expected to make only slightly oblique angles with the axis of the neck.

Diagrams illustrating the differences in rotation of the femoral growth disc in flattened (widened) hip socket:

in severely enfeebled bone	in moderately enfeebled bone	in slightly enfeebled bone	in normal bone

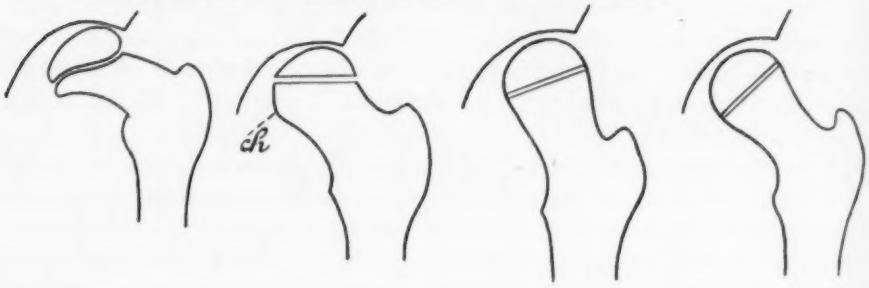


Fig. 28	Fig. 29	Fig. 30	Fig. 31
Coxa vara.	Normally shaped femoral neck.	Coxa valga.	Normal shape.
The growth-disc and the femoral neck are at:			
very oblique angles.	moderately oblique angles.	slightly oblique angles.	right angles.

Note: In cases of flattened (widened) hip socket and moderate feebleness of growth the position of the growth disc comes nearest to the horizontal.

And between these two classes of cases there is the moderately enfeebled femoral neck, which is neither bent into a varus position nor raised into a valgus position, and hence has the normal form. However, the moderately enfeebled femoral neck differs from the normal in that its growth disc does not react in the same way. Indeed, whereas the growth disc of the normal femoral neck can practically bear every increase of pressure without reacting with decrease of growth, the moderately enfeebled femoral neck in flattened hip socket, which we are considering, must be expected to show decrease of growth on the lateral side under the influence of the couple of forces $AP \times BC$ in a less degree than the severely enfeebled femoral neck (depicted in Figure 28) but to a greater extent than the slightly enfeebled neck shown in Figure 30, so that this growth disc makes less oblique angles with the axis of the femoral neck than it does in Figure 28, but more oblique ones than those represented in Figure 30.

It should be emphasized that in flattened hip socket with moderate feebleness of growth *the position of the growth disc comes nearest to the horizontal.* It is true, in severe feebleness of growth there is more decrease of growth laterally,—*i.e.*, on the side of the most pressure—through which there is more rotation of the growth disc with regard to the axis of the femoral neck, but the femoral neck at the same time bends to coxa vara, thus lessening the chance for the growth disc to lie in a horizontal position. In coxa valga the raising of the femoral neck indeed helps the growth disc to approach a horizontal position but here the rotation of the disc in

Diagrams in which the muscle forces *BR* (See Fig. 17) have been analyzed into such as act parallel to the growth disc and those which act perpendicularly to it.

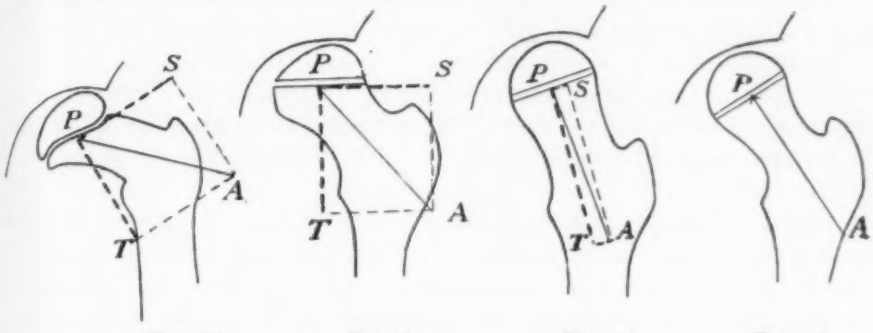


FIG. 32 FIG. 33 FIG. 34 FIG. 35

It is evident that in cases of flattened (widened) hip socket with moderately enfeebled bone the femoral neck is most liable to be displaced inward alongside the head.

relation to the femoral neck,—*i.e.*, the decrease of growth on the lateral side of the greatest pressure—is too slight to give it a horizontal position.

We shall now learn the reason why the very horizontal position of the growth disc is of so much importance in the ensuing changes in femoral neck and head.

Besides the couple of forces $AP \times BC$ we must take into account the force *BR*, shown in Figures 25, 26, and 27. For the sake of clearness we shall consider it as acting on a point of the growth disc (See *AP*, Figures 32, 33, and 34). This is allowable, because at the moment we are neglecting the action of the couple of forces. If we analyze *AP* (Figs. 32, 33, and 34) into one component which runs parallel to the growth disc, and a second one which acts perpendicularly to it, then *PS* is the force with which the obliquely directed muscle forces (all of which act on and below the major trochanter) strive to displace the neck of the femur inwards along side the head (or the head laterally alongside the neck). And it is patent that the probability of displacement is greatest in Figure 33,—*i.e.*, where the growth disc has a horizontal position as is most frequently the case in moderate feebleness of growth,—whilst cases of flattened hip socket with severe feebleness of growth come next in their liability to such a displacement and in coxa valga there is still less chance of lateral displacement of the head. Lastly, in flattened hip socket with a normal condition of the skeleton, the probability of lateral displacement of the head is practically naught.

Now in cases where the hip socket is wide (or flat) enough, we see that the femoral head on the horizontal growth disc does become displaced sideways, until the mesial edge of the femoral neck touches the mesial part of the socket floor. *And this lateral displacement of the femoral head must be looked upon as meaning injury to the blood-vessels and bone lamellae, hence as a trauma to the femoral neck and head.*

Legg, Allison, Perthes, Calvé, Walderström, and others have expressed their opinion that coxa plana has a traumatic origin. However, none of

them have been able to designate the trauma. We consider the trauma to consist in the lateral displacement of the femoral head after it has slowly and gradually rotated into the horizontal position through the couple of forces $AP \times BC$. Hence the word "trauma" should be taken in the sense of an injury caused by internal forces, although forceful stresses suddenly brought about by external forces, as by a fall or a jump, will be liable to precipitate the displacement of the femoral head, as may be readily understood.

In the above we have referred to the fact that the rotation of the growth disc on the femoral neck may be compared with that of the growth disc at the lower end of the femur which leads to the formation of knock-knees. The latter takes some time to develop, the longer the less the bone is enfeebled, sometimes years. Hence the development of coxa plana must be expected to take some years, because the rotation of the femoral head to the horizontal position has to initiate it.

(3) The Degree of Width (flattening) of the Hip Socket.

The wider the hip socket, *ceteris paribus*, the smaller the area of contact with the head and the greater the action of the couple of forces. This difference may seem small in its effect, yet its share in the sequence of events cannot be denied.

The width of the socket is of more importance with regard to the fact that the lateral displacement of the femoral head, which may be considered to bring about injury to the blood-vessels, must stop as soon as the mesial edge of the femoral neck touches the floor of the socket. This may be the reason on the one hand why it has never been observed that the head was altogether displaced to the side of,—that is, off—the neck, and on the other hand, that where the flattening (widening) of the socket is only slight, a lateral displacement of the femoral head takes place to such a small extent that no real harm is done to the blood-vessels and cancellous tissue. In fact we often find along with coxa plana in the same subject an initial stage of coxa plana on the other side,—*i.e.*, a horizontal position of the femoral head, in which head and socket have become perfectly congruous and in which no further deformation takes place.

Inasmuch as these changes in the femoral head which we shall study presently (jockey-cap form, flattening), or in the socket (depression, "*coup d'ongle*", in the socket roof) may be considered as an approximation to congruity of the two surfaces, these changes must be expected to come to an end all the more quickly the smaller the incongruity is,—*i.e.*, the less flat (or wide) the socket is.

(4) Increased Body Weight.

Where the body weight is increased, the lines in Figures 25–27, AP and BR, should be imagined longer because they represent greater forces. All the changes which we have considered will then, *ceteris paribus*, take place earlier and at a quicker rate. The rachitic child will not so easily grow fat. This is easier in the cases of moderate and still more so in the cases of slight feebleness of growth. Usually the wish of the parents to strengthen

the child is the cause of his becoming unduly fat. Hence we see the results of increased body weight mostly in cases of slight feebleness of growth,—*i.e.*, in coxa valga, as an enhanced frequence of slipping epiphysis.

(5) Traumata.

The influence of traumata (falling, jumping, bumping) is very similar to that of increased body weight. In such cases, too, the acting forces are to be considered as being enlarged. Their influence may be stronger, but they work less continually than the forces of increased body weight. Thus traumata must be expected to hasten not so much the gradual changes in the growth process (as, for example, the rotation of the femoral head on the neck) as those taking place suddenly, such as coxa fracta, lateral displacement of the femoral head, flattening of the femoral head, and slipping epiphysis.

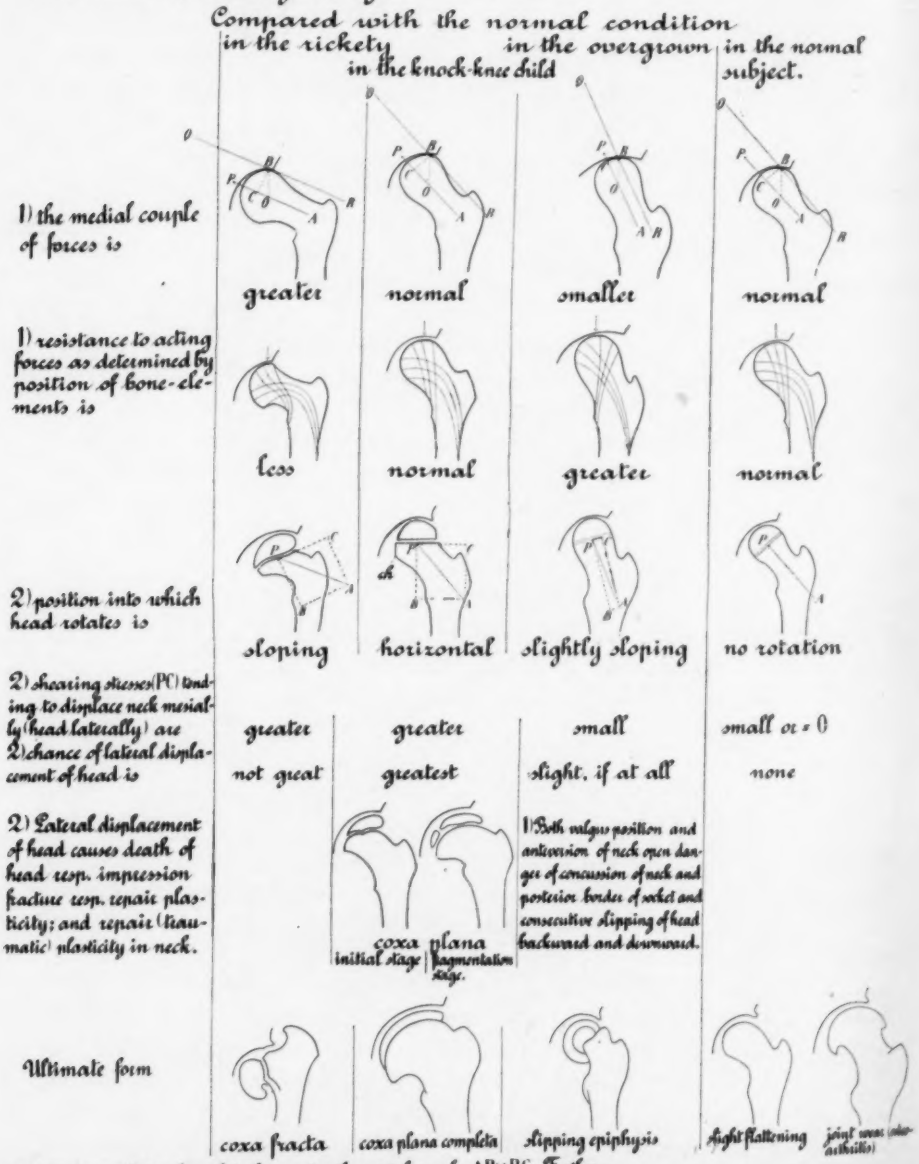
Summarizing, the following consequences are to be expected of flattened (wide) hip socket in severe, moderate, and slight feebleness of growth, and in normal unenfeebled bones:

Flattened hip socket in severely enfeebled bone increases the risk of coxa vara and coxa fracta. In moderately enfeebled bone it leads to a rotation of the growth disc to the horizontal position, followed by a lateral displacement of the head on the neck, till the mesial edge of the neck touches the floor of the socket. In slightly enfeebled bone it causes coxa valga and sometimes also slipping epiphysis. The risk of the occurrence of slipping epiphysis is increased by anteversion of the femoral neck as well as by increased body weight.

If we compare the results of coxa fracta, lateral displacement of the femoral head and slipping epiphysis, it is clear that the first and last mentioned conditions render the subject unfit for carrying the body weight for a long period of time, who is indeed spared from doing so. On the other hand, in cases where the head is displaced laterally the hip joint may go on carrying the undiminished body weight through the flattened socket. Where the displacement is sufficiently great, the vessels going to and coming from the femoral head are torn or closed together by pressure, by reason of which circulatory disturbances and finally necrosis of the head is initiated. The laterally displaced head must thus be considered to lie either partly or altogether dead on the injured cancellous tissue of the femoral neck under the pressure of the flattened socket. Pathological-anatomical study and experimental research, which will be discussed in the following chapter, have shown that dead bone is brittle. Hence we shall expect that the laterally displaced head will be pressed flat. On another occasion we have adduced grounds for the assumption that cancellous tissue, when injured, is plastic,—*i.e.*, shows "traumatic plasticity". Therefore, the injured femoral neck must be expected to be shortened or broadened by the body weight. The following chapters will test these deductions to the facts.

In the femoral head and neck of the normal, unenfeebled skeleton, the influence of a flattened socket is limited to slight flattening of the head.

B). In flat hipsocket the intensity of the altered stresses is determined by 1) position of neck, 2) position of growth-disc, 3) width of socket, 4) traumata, 5) body-weight.


Compared with the normal condition
in the rickety
in the knock-knee child
in the overgrown
in the normal subject.
1) the medial couple of forces is
greater
normal
smaller
normal
1) resistance to acting forces as determined by position of bone-elements is
less
normal
greater
normal
2) position into which head rotates is
sloping
horizontal
slightly sloping
no rotation
2) shearing stresses (PC) tending to displace neck mesially (head laterally) are
greater
greater
small
small or = 0
2) chance of lateral displacement of head is
not great
greatest
slight, if at all
none
2) Lateral displacement of head causes death of head resp. impression fracture resp. repair plasticity; and repair (traumatic) plasticity in neck.
coxa plana
initial stage
fragmentation stage.
1) Both valgus position and antiversion of neck open danger of concussion of neck and posterior border of socket and consecutive slipping of head backward and downward.
Ultimate form
coxa fracta
coxa plana completa
slipping epiphysis
slight flattening
joint wear (osteoarthritis)

3) a) The wider (flatter) the socket, the greater the mesial couple AP × BC. Further:
b) Lateral displacement of head will be arrested as soon as „chin" is in contact with (mesial portion of) socket. Moreover,
c) as soon as congruity of joint surfaces is obtained, deformation may be checked. Hence
d) in the same individual the greater changes are in the wider socket, the initial-stage in the less wide.
4 and 5) Trauma and excessive bodyweight promote displacement of head in the diverse directions.

N.B. In the above the effect of flat (wide) hipsocket with normal roof has been considered only. Complication with infection has been left out of consideration.

PLATE 3.

There occurs much more slowly and later than in the preceding cases what Preiser has described as the consequence of an incongruity of the joint surfaces. We would term it joint wear, and it is known as malum coxae or osteo-arthritis.

In Plate 3 the most important points of Chapter II *B* are tabulated.

III. CLINICAL OBSERVATIONS ILLUSTRATING AND SUPPLEMENTING THE ABOVE VIEWS

A. Pathological Anatomy in Coxa Plana.

During the last few years much histological research has been made on the femoral head in the fragmentation stage of coxa plana, and it has been found that aseptic necrosis of the bone and bone marrow takes place in the deformed femoral head. The dead bone lies in pieces, a condition to which Axhausen[9] gave the name "impression fracture", the pieces of bone being separated from each other by a layer of bone crumbs and bone meal. These are formed by the friction of the dead pieces of bone against each other. This is rightly considered by that author to be a proof that fracture has occurred after death of the bone,—*i.e.*, that the "impression fracture" is a pathological fracture. Joint cartilage and growth cartilage are still living. From below the edge of the joint cartilage blood-vessels and young connective tissue enter the femoral head. These initiate the process of demarcation (Axhausen) and of substitution of living bone for the dead bone. During these processes the head of the femur gradually undergoes a change of form.

Kidner[10] cut two pieces out of the head and neck of a coxa plana. An examination by Phemister in Chicago showed necrosis of the bone and of the cartilage in them, with the absorption of both, and substitution of living bone for dead bone. Signs of inflammation were absent. Patient had at the same time a spina bifida occulta—which we have often seen associated with congenital mechanical malformations and which we have learned to look upon as the result of increased intra-uterine pressure[8] exercised in a much earlier period of foetal life than that which brings about the widening or flattening of the hip socket.

Exactly the same changes have been found in slipping epiphysis as well as in Köhler's change of the os naviculare pedis and Kienböck's affection of the lunatum carpi. There is absolute consensus of opinion about the nature of these phenomena and also as to the cause of the necrosis which amounts to a shutting off of the blood supply. Axhausen finds no cause for the stopping of the blood supply in coxa plana, and suggests that it may be brought about by bland mycotic-embolic processes, while Kappis (at least in the os lunatum of the hand) thinks that the cessation of the blood supply must be attributed to trauma and that the possibility of infection may be excluded.

Walther Müller[11] has brought about slipping epiphysis subcutaneously in rabbits and obtained changes fully corresponding to those described above. He thinks that where the x-ray photograph shows an important displacement of the femoral head on the neck, necrosis of the head is to be expected.

How is it that such a keen observer as Axhausen seeks for the cause of the arrest of the blood supply in coxa plana in bland mycotic-embolic processes? It is because he has restricted his research to the microscopic data. All other phenomena of coxa plana, both those which constitute the condition as such and those which are associated with it, are given no consideration whatsoever,—such as the hip socket and its changes, the horizontal position of the femoral head and its lateral displacement, and also the relationship of coxa plana with congenital hip dislocation, with coxa vara, coxa valga, and slipping epiphysis. It is needless to say that these changes are not brought about by emboli. The mere fact that the emboli would occur only between the ages of three and ten years, occasioning coxa plana, and not in later years, makes Axhausen's hypothesis inadmissible. On the other hand, the lateral displacement of the femoral head on the neck fully accounts for the disturbance of the blood supply to the femoral head and the subsequent necrosis, just as well as the period of time required for the rotation of the femoral head which precedes this lateral displacement accounts for the typical age incidence,—*viz.*, third to tenth year.

We must leave undecided whether or not a slight displacement of the head, not sufficient to tear the blood-vessels, may yet lead to a pressure on them which is sufficient to close both veins and lymph vessels, thus causing congestion and rendering the bone brittle. Our experience in cases of march foot[12],—*i.e.*, cramp of the interossei muscles—is in favor of this view; in this condition we regularly see that the oedematous bone becomes brittle, often breaking unnoticed. Similar was our experience in the case of one of our patients, a lady with chronic oedema in abdomen and legs, presumably caused by obstruction of the thoracic duct, who broke both femoral necks by simply falling from a chair on which she was sitting.

Walther Müller found the femoral head easily deformable after experimental detachment of the epiphysis. He assumes, like Axhausen, that the dead bone in the femoral head is brittle. However, he was unable to produce the secondary "impression fracture" in any of his experiments made on rabbits. He considers it possible that the cause of this difference between man and animals lies in the upright gait of man,—as if greater demands on the bones did not entail a corresponding increase in the firmness of their structure! In Axhausen's experiments femoral head and hip socket were congruous; and it is not clear how a congruous socket should flatten the femoral head. The incidence of a stronger development in the build of the bony system did not accompany the greater demands put upon it. The "impression fracture" requires the pressure of a flattened (widened) socket.

The fact that the "impression fracture" of coxa plana occurs chiefly between the fifth and twelfth years is accounted for by Müller by the assumption of a greater sensitiveness of the tissues during those years,—for which assumption he gives no further reasons. In our opinion the cause of the "impression fracture" is the necrosis of the femoral head ensuing from its lateral displacement, while the flattening (widening) of the hip socket determines a concentration of the functional stresses on a small area of the femoral head. The fact that the condition develops only after the patient has been walking for some years is to be attributed to the fact that it requires some years of function for femoral head and growth disc to rotate into the horizontal position, just as the rotation of the growth disc near the knee joint may demand years in the development of knock-knees.

Axhausen has observed a demarcation process developing in the necrotic femoral head which had sustained an "impression fracture". This is the first stage of the process of substitution of living bone (*"Umbaukopf"* of W. Müller). It is in this stage that the spread-out head and the growth disc, together with the upper portion of the femoral neck, adapt themselves to the hip socket, so much so that in the end their outlines run fairly parallel to the socket line. Hence the substitution of living bone for dead bone appears to be associated with great plasticity of the bony tissues ("traumatic plasticity", or repair plasticity)[13].

Less attention has been paid to the broadening and shortening of the femoral neck than to the changes in the head. It does not seem bold to assume that the displacement of the femoral head is accompanied by injury to the bone elements in the neck. The dark spot in the x-ray often visible below the middle of the growth disc, first described by Waldenström, points to a deficiency of lime salts at that place. It is like that described by Kienböck in the lunatum. And the fact that the neck takes on the form of a pear justifies the assumption that the plasticity is greatest near the growth disc,—*i.e.*, in the neighborhood of the dark spot. Leriche and Policard, and other obervers, have shown that the union of fractured bone elements is associated with absorption of lime salts and rarefaction in them.[14] Hence damaged cancellous tissue, which during recovery,—*i.e.*, during this resorption—is made to withstand functional pressure, cannot bear this pressure without undergoing further deformation. Here, too, there is what we call traumatic plasticity or recovery plasticity. It is the form of the hip socket which evidently determines the direction in which the deformation of both neck and head of femur shall take place, so that in coxa plana completa the growth disc is also curved and runs parallel to the socket line and the head of the femur lies like a thin, broad layer evenly distributed over the shortened and widened femoral neck. The fact that the femoral neck develops no pressure fracture is probably dependent on the blood supply being better, necrosis thus being excluded.

After the femoral head has sustained the "impression fracture", it is differentiated from the neck by a greater amount of lime salts in the

Diagrams showing the various stages of development of coxa plana:

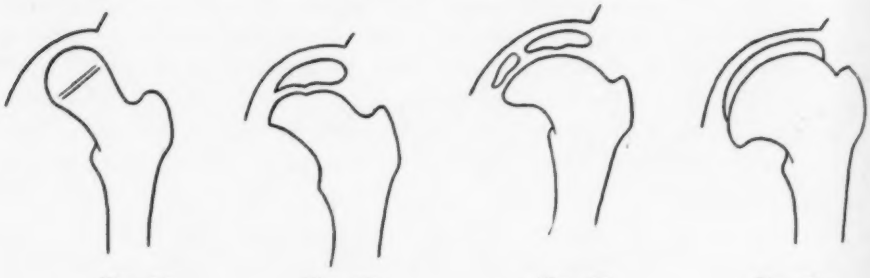


FIG. 36

Normally shaped femur, of moderately enfeebled bone, in flattened hip socket.

FIG. 37

Initial stage of coxa plana (Note horizontal position of femoral head and lateral displacement).

FIG. 38

Fragmentation stage (Note widening of neck and parallel course of growth-disc and joint surface).

FIG. 39

Coxa plana completa (The fragments of the head have fused).

compressed part and by rents and tears. That is to say that areas rich in lime salts are separated from each other by areas poor in lime salts. Usually the largest tear in the bony head is noticeable at the place where the bend in the growth disc is most marked. From the initial stage of coxa plana, in which the femoral head is horizontal and laterally displaced, and the growth disc often shows a typical notch (pointed down) (Fig. 37), the fragmentation stage of coxa plana has thus been reached (Fig. 38). After some time it passes into that of coxa plana completa, when the various parts of the head of the femur have fused again and the femoral head and neck have adapted themselves more or less accurately to the form of the wide (flat) hip socket,—*i.e.*, have developed more or less complete congruity to the socket (Fig. 39).

In all cases of coxa plana which have hitherto been described, the joint cartilage has been found uninjured. Only in one preparation—that of Pommer, represented by Kreuter[15]—the joint cartilage is clearly interrupted above the place where the bend in the growth disc is most marked. The edges of this interruption are thick, as if they had been torn away from each other, and not pointed as if they had been worn away. In Kreuter's preparation the joint cartilage is slightly undulated, as if it had become too large for its contents by reason of the flattening of the femoral head. The hypothesis seems justified that small cavities under the joint cartilage (Compare also Delchef's preparation) are associated with such undulations of the cartilage. For the development of such cavities the previous pages may have given the cause. Pommer found crumbling and bleeding (*"Zertrümmerungs und Blutungsherde"*) in his preparation and considers traumata to be the cause.[16]

All in all, not a single phenomenon has been discovered in the anatomy and pathology of coxa plana that is in disagreement with our view that

injury of vessels due to the lateral displacement of the femoral head is the cause of death of bone, fragmentation, and flattening of the femoral head in coxa plana. On the contrary, all phenomena are in accord with it.

B. X-ray Photographs.

The x-rays furnish evidence which is in agreement with the previous deductions, as may become patent from what follows:

(1) Coincidence of Coxa Vara (fracta) and Coxa Plana in Cases with Flattened Hip Socket.

The patient, whose x-ray is shown in Figure 40, a nine-year-old girl, has coxa vara on both sides. On the left side, where the socket floor is thicker and hence the socket is flatter than on the right side, the varus position is more marked, which is in accordance with our view that a flat socket enhances the risk of development of coxa vara (See Figure 22). The angle between the axis of the neck and the growth disc is very oblique, which evidences either relative or absolute decrease of growth on the lateral side, such as is always very marked in cases of severe feebleness of growth (See Figure 28). In connection with this there is a slight head-in-neck position, probably also in part due to lateral displacement. The mesial parts of the head and the neck are poor in lime salts, a phenomenon which we regularly observe in cases of flattened hip socket. This too, is in accordance with our view that those parts are not in contact with the hip socket, and hence the pressure stresses which would lead to a densification of the bone,—*i.e.*, a deposition of lime salts—have not been brought into play.

Figure 41, too, (that of a twelve-year-old boy) shows a wide hip socket on the right side due to ischium varum, coxa vara trochanterica, or coxa fracta, and on the left side slight bending of the neck into the varus position. Note that the greater change is on the side of the wider socket. There is no bending of the long bones, no evidence of feebleness of growth

FIG. 40
A. B., female.

FIG. 41
G. R., male, aged twelve.

FIG. 42

of the skeleton, as in the patient of Figure 40. Moreover, the condition has developed much later; at any rate, the symptoms have presented themselves much later. Hence, although the widening of the hip socket cannot be denied a share in the development of the deformity of head and neck, severe feebleness of growth (rickets) cannot in this case be made responsible for it as it was in Figure 40. This coincidence of coxa fracta and wide hip socket (ischium varum) in a skeleton hardly affected by feebleness of growth is anything but rare. And though for the causation of coxa fracta external forces cannot be excluded, still the coincidence of coxa fracta and a wide hip socket (ischium varum) in an unenfeebled skeleton is easily understood, if we assume that pressure along the axis of the femur, acting before birth, has caused both the congenital coxa vara and the ischium varum (See Figures 5, 7, and 8).

Figure 42 shows the relationship between coxa fracta (See right side) and coxa plana (See left side). The patient, an eight-year-old girl, shows over the whole body and the head traces of having suffered from severe feebleness of growth (rickets) during the first years of life. Both hip sockets are flat, because of thick socket floors. On the right side there is, moreover, abnormal width of the socket (through ischium varum). Here again the coxa fracta and ischium varum may have a common cause in prenatal pressure on the knee of the foetus in the direction of the femoral axis; or otherwise, the vertical forces after birth may have acted more intensely in the wide socket on the right side than in the narrower left socket, in accordance with the argument of Chapter II.

Lastly, Figure 43, that of a seven-year-old boy, shows the relationship between coxa plana and coxa vara. On both sides the socket is flat (due to a thick socket floor). On the right side there is, moreover, ischium varum. Whereas in the less flat socket (on the left) only a rotated growth disc is present, with "chin formation",—in brief, the initial stage of coxa plana; the flatter side shows the fragmentation stage of coxa plana.

(2) Coincidence of Coxa Plana and Coxa Valga in Flattened Hip Sockets.

Figure 44 shows a straightened socket line on both sides. On the right side this is due to too thick a socket floor; and the flattening of this

socket is enhanced by slight shelving of its roof. The left side shows ischium varum,—*i.e.*, too wide a hip socket. There the flattening (widening) is most marked, and in femoral head and neck the initial stage of coxa plana has been reached: horizontal position of the growth disc with the typical "chin formation" and lateral displacement of the head (head-in neck position).

FIG. 43

Three years and ten months afterwards we invited this patient to come for x-rays. We expected development of coxa plana in the left hip, because in Figure 44 along with the horizontal position of the growth disc there was a gap mesially between the head and the socket curve. Figure 45, indeed, showed complete coxa plana. The child is of normal height, has muscle weakness and knock-knees. Ischium varum (See Figure 44) was present before coxa plana, and did not become worse during the development of coxa plana. This is in contradiction to the assertion of some authors that ischium varum is the result of coxa plana. On both sides almost perfect congruity has developed between head and socket.

On the right side the jockey-cap shape of the femoral head is marked; the head is flattened on the mesial side. We regularly observe the jockey-cap form in cases of flat hip socket after the rotation of the femoral head to the horizontal position. It is to be considered as an adaptation of the head to the straightened course of the socket line.

In comparing Figures 44 and 45 it may be noticed that after the lapse of three years and ten months the right femoral neck has taken up a more

FIG. 44
M. R., female, aged three.

FIG. 45
M. R., female, aged seven.

vertical position. This change is probably partly due to a difference in the rotation of the femur: in Figure 45 the trochanter minor on the right side can be seen, whereas it is invisible in Figure 44. However, if one takes a femur in one's hand, and imitates with it the two positions of the right femur represented in Figures 44 and 45, the difference in the degree of verticalness of the neck in the two positions is far less than is seen in the two figures. Hence, here coxa valga has developed in a flattened hip socket. There is a slight head-in-neck position, although slighter than there was on the left side three years ago. Still further lateral displacement of the head on the right side than is seen in Figure 45 can hardly be expected—and hence neither the development of coxa plana—because the "chin" just about touches the socket floor, the circumference of head and "chin" running fairly parallel with the socket line. The head and neck are certainly slightly broadened and the head is flattened, still the growth disc has not taken on the bent course which it has done on the other side,—after its lateral displacement. Hence, in the right socket, which is less flat than the left one, we see the lesser changes.

It is interesting that in the course of three or four years the right hip socket has become deeper; the right socket line in Figure 45 runs a more rounded course than in Figure 44. Hence, here the adaptation of the socket to the femoral head is noticeable as well as, reversely, adaptation of the head to the socket. But all the same, in Figure 45 the socket line is less curved than it is normally and the outer edge of the femoral neck is situated too laterally with regard to the outer line of the os ilii, while the inner edge of the femoral neck stands higher than the upper border of the foramen obturatum. For all that, this secondary deepening of the hip socket is in contradiction to the conception of some authors who believe in a tendency of the hip socket to undergo secondary flattening by the femoral head.

It has been pointed out from many sides that in coxa plana the lower edge of the femoral neck runs in the continuation line of the upper border of the foramen obturatum, as it does normally; and some consider this to be a proof that the femur has not been displaced with regard to the os pubis or reversely. In Figure 44 on the left side, the lower edge of the femoral neck is clearly too high; in Figure 45, on the other hand, it is too low. Evidently the displacement of the femoral neck in coxa plana is often masked by the pear-like broadening of the femoral neck; as soon as the femoral head in its process of broadening again fills the enlarged socket, the lower edge of the neck again runs in a continuation line with the upper border of the foramen obturatum.

Figure 46 shows coxa valga on both sides. Here the socket floor is too thick on both sides, the socket too flat; a continuation line of the lateral edge of the femoral neck ascends laterally to that of the os ilium. There is also evident lipping of the socket roof on the right side.

One can easily recognize the primary flatness of the socket (due to thickness of the socket floor) as the cause of the jockey-cap form of the

head. This is especially clear on the right side, while on both sides the depression in the socket roof, described by Calot as "*coup d'ongle*" bespeaks a concentration of the functional pressure on a small area of the socket roof, also due to the flatness of the socket. These two phenomena,—*viz.*, the jockey-cap form of the femoral head and the depression in the socket roof—are, together with the rotation of the head to the horizontal position, the unmistakeable tokens of the primary incongruence between femoral head and hip socket.

The question arises: why does the socket give way on the upper side to the pressure of the head, as it regularly does in flattened (widened) socket in the initial stage of coxa plana? and why, on the contrary, does the head give way to the socket on the mesial side so as to develop the jockey-cap form characteristic of the initial stage of coxa plana? Notice that the femoral head in Figure 46, just as in Figure 45, is in too horizontal a position. Laterally too large a part of the head is left without contact with the socket; and mesially, especially in Figure 45, part of the femoral neck has clearly been promoted, as it were, to joint surface,—*i.e.*, it has come into contact with the hip socket. The pressure through the socket on the mesial part of the head, therefore, acts at a smaller angle with the growth disc than normally,—*i.e.*, the bone elements in the head are affected by pressure in a direction which acts more laterally than is normally the case. In our study "On Boneformation"[7] we have brought forward grounds for the assumption that pressure, acting at right angles to the stresses for which the bone has been formed, easily leads to waste of bone substance. The flattening on the mesial side of the head may possibly be the outcome of this. The reason why the opposite takes place in the upper portion of the femoral head, in that it causes a depression in the upper part of the socket, may therefore be due to the more advantageous position its bone elements occupy with regard to the direction of the acting forces.

If we compare the position of the growth discs with regard to the axis of the femoral neck in Figures 40, 44, 45, and 46, it becomes patent that the angles which they form are more oblique than normal, and most oblique in Figure 40. Here, therefore, the difference in growth between the mesial and the lateral parts of the growth disc is greatest. The "chin" on the mesial side appears to be highest in Figures 44 and 45, and least high in Figure 40. If this "chin" may be considered as the outcome of increase of growth to decrease of pressure (through the action of the couple of forces and a concentration of pressure on a smaller

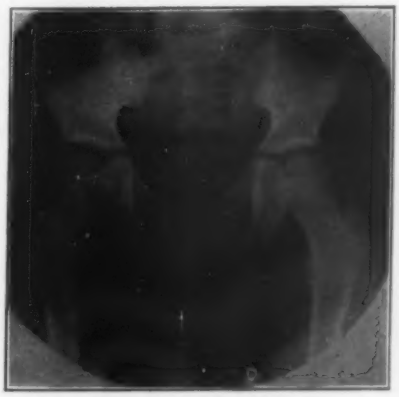


FIG. 46

area situated laterally), then we may say that there is an evident increase in growth on the mesial side in Figures 44 and 45 in comparison with the normal, in Figure 46 a doubtful increase, and in Figure 40 a still less evident increase.

In our study on "Feebleness of Growth and Congenital Dwarfism" we have tried to prove that increased feebleness of growth is characterized by enchanced irritability and enhanced fatigueability (See Rule 6, page 479).

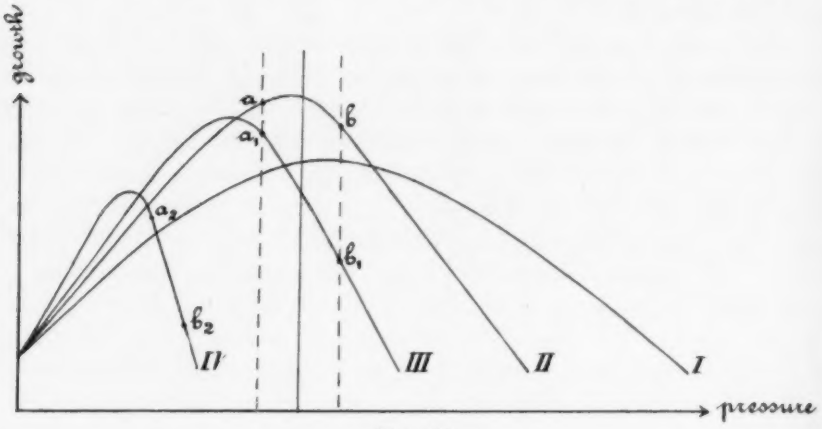


FIG. 47

Hence, if in Figure 47 curve *I* represents the growth of a normal individual under the influence of increasing pressure, the growth of the femoral neck in Figure 40 may be represented by the curve *IIab* of Figure 47, (*a* rendering the growth of the mesial and *b* that of the lateral part of the femoral neck) and the growth of the neck of Figure 45 may be represented by a steeper curve,—*i.e.*, one rendering the growth of a more enfeebled skeleton,—*viz.*, the curve $IIIa_1b_1$ of Figure 47—and lastly the growth of the femoral neck in Figure 20 may be represented by a still steeper curve,—*i.e.*, one rendering the growth of a still more enfeebled skeleton—in which even point *a* remains below the normal. In the last mentioned case, where all the parts of the skeleton are bent, the whole individual remains too small, and the pressure is also less than normal, so that the growth relationship may be roughly approximated by IVa_2b_2 in Figure 47. We do not mean to put any force of argument into these curves, but only to show that differences in the amount of "chin formation" which the femoral neck shows during the rotation of the head into the horizontal position, are in accordance with our views,—*viz.*, that differences in the obliqueness of the growth disc to the axis of the neck, as well as differences in the height of the "chin", may be dependent on differences in the degree of feebleness of growth of the skeleton,—*i.e.*, on differences in irritability and fatigueability of the power of growth of the skeleton.

In the above we have made the mesial displacement of the femoral neck under the head,—*i.e.*, the lateral displacement of the head on the

neck—responsible for the development of coxa plana. And for this displacement, two conditions have to be fulfilled,—*viz.:*

(1) a horizontal position of the growth disc;

(2) a space left between the mesial edge of the neck and the hip socket, even when the mesial part of the head is in contact with the socket floor.

These two conditions have to be fulfilled in cases where the socket roof is intact. If this is shelving, the growth disc does not need to be quite horizontal, but a lateral displacement may occur even provided the growth disc diverges laterally from the shelving socket roof. Under a normal, horizontal socket roof a growth disc, sloping up laterally, would necessitate a lowering of the femur in case of its mesial displacement with regard to the femoral head; and all functional stresses are opposed to such lowering. Under a shelving socket roof, however, a divergence between growth disc and socket roof may admit of a mesial displacement of the femoral neck with regard to the head without such lowering, the femoral head finding space for unimpeded lateral and at the same time upward displacement. This divergence between socket roof and growth disc is not a necessary condition where the growth disc is horizontal. When the lateral edge of the socket roof, in a wide or flat hip socket, is directed downwards because of a deep depression (*"coup d'ongle"*) in the middle of the socket roof, the femoral neck with a horizontal growth disc may all the more easily be displaced mesially with regard to the head, which is, as it were, caught in the depression of socket. Yet, even with a horizontal growth disc, a shelving socket roof is conducive to lateral displacement of the femoral head. However, the more the socket roof shelves, the less becomes the couple of forces $AP \times BC$ (See Figure 26),—*i.e.*, the less the forces rotating the growth disc to the horizontal.

It stands to reason that both in the shelving and in the horizontal socket roof the lateral displacement of the femoral head is checked at the moment when the mesial edges of femoral neck and head both come into contact with the hip socket.

Not long ago Walther Müller[17] averred that a lateral displacement of the femoral head is liable to occur where "the space between the lateral edge of the hip socket and the lateral upper corner of the femoral neck is greater than the height of the femoral head in its highest part", (or, as we have said above, where the socket roof and growth disc diverge laterally). In saying this Müller has overlooked: firstly, the second condition to be fulfilled for a lateral displacement,—*viz.*, that the mesial edge of the femoral neck must not touch the socket floor; and secondly, that displacement is also possible *without* lateral divergence of growth disc and socket roof,—*viz.*, when the growth disc is horizontal.

Although lateral displacement of the femoral head on a sloping growth disc which diverges laterally with the socket roof causes vessel tears, and especially necrosis, and traumatic plasticity just as much as where the growth disc is horizontal, yet the results are different: the forces of pres-

sure which act upon femoral head and neck in cases of an intact socket roof and which lead to the flattening and broadening characteristic of coxa plana, come less into play the more shelving the socket roof is. In shelving socket roof the flattening of the displaced femoral head is most marked on the mesial side.

(3) Coincidence of Coxa Valga and Slipping Epiphysis in Cases with Flattened Hip Sockets.

We have pointed out in the above that the femoral neck is more resistant to vertical pressure when elevated into the valgus position. It becomes harder, and moreover in the process of its elevation the couple of forces (See $AP \times BC$ in Figures 26 and 27) exhausts itself, as it were; and consequently the force which tends to displace the femoral head laterally also becomes less.

In agreement with this the coxa valga in the flattened hip socket on the left of Figure 48 is attended by a relatively deep depression (*"coup d'ongle"*) in the socket roof; the flattening of the head, on the contrary, is slight. The left side presents a thick socket floor as well as an ischium varum, hence a socket which is both flat and wide. These changes might be considered to be due to asymmetrical exposure; but the femoral neck shows only one group of trabeculae which run parallel and are directed towards the "depression" in the socket roof. A second group of trabeculae which normally run from the major trochanter to the mesial side of the head is missing. The pressure which should maintain them—for pressure is the only stimulus for bone formation[7]—has evidently been missing. The internal structure of this femoral neck in Figure 48 therefore disproves the assumption of some authors that the width of the hip socket is a secondary phenomenon due to pressure of the femoral head. On each side of the parallel trabeculae running longitudinally in the femoral neck there is a scarcity of lime salts, this being another token of absence of pressure forces.

FIG. 48

The femoral neck on the left side is broadened as a whole, quite different from the pear shape of the femoral neck in coxa plana. In the latter condition the plasticity is greatest near the growth disc; in this coxa valga, however, the plasticity is divided equally over the whole length of the neck. We have termed the local plasticity in coxa plana *"traumatic or repair plasticity"*

because a local injury to the cancellous tissue had to be assumed as a consequence of the lateral displacement of the femoral head. In this coxa valga the lateral displacement of the head is absent or at least doubtful. Hence there is nothing to cause a traumatic plasticity. We tend to consider this even thickening of the neck as the outcome of *normal plasticity through excess of pressure.*

FIG. 49
Frontal section through normal femoral head and its socket (for comparison).

All these facts,—*viz.*, the relatively large depression in the socket roof (*"coup d'ongle"*), the relatively slight flattening of the femoral head, the parallel course of the trabeculae, the scarcity of lime salts on either side of them, the total or almost total absence of lateral displacement of the femoral head (although the growth disc is almost horizontal—See Figure 49)—are in accordance with our view that the flattened (wide) hip socket is the cause of the valgus position of the femoral neck.

A striking phenomenon is the notched appearance of this femoral neck. It is due to the large and lowly situated "chin" on its inner side and an angular bend in the outer side. It seems reasonable to assume that it was caused by a relatively rapid rotation of the growth disc, its mesial part growing more quickly than its lateral part. Theoretically the growth disc might be expected to describe a complete circle with its mesial side, thus producing a femoral neck which might be strongly bent,—*i.e.*, very convex on its inner side. Practically this does not occur; the couple of forces becoming less and less as the neck rises would be naught as soon as the neck should stand up vertically. It is patent that even before that the couple of forces has lost enough of its power to be able to cause a difference in growth (in favor of the inner side). And at that moment the rest of the neck continues its growth in a straight direction—as may be observed in the figure—upwards of the indentation in the neck,—*i.e.*, of the "chin" on the inner, and the angular bend on the outer side of the neck.

Walther Müller believes that coxa valga is the "result of a lateral displacement of the femoral head on the neck".

We have already mentioned the fact that he attributed the lateral displacement of the femoral head to a lateral divergence of growth disc and socket roof (See page 503). *Displacement of the growth disc* can never lead to such results. In fact, strictly speaking, continued growth of a growth disc after lateral displacement can only result in a *bayonet-shaped femoral neck.* The angular bend through which the upper portion of the neck stands straighter up than the lower half can practically be brought about only by a relatively hidden change of the direction of growth due to rotation of the growth disc. In the foregoing pages we have made the mesial couple of forces $AP \times BC$ responsible for this rotation (See Figures

25, 26, 27). Moreover, the lateral divergence of growth disc and socket roof (which W. Müller considers to be a condition for the displacement of head and growth disc) is missing. Accepting W. Müller's view of the origin of coxa valga would thus create confusion in our understanding of these hip affections. This is all the more the case since displacement of the growth disc must always be considered as a trauma which brings serious consequences in its train; and these consequences are the more serious, the more completely the femoral head is subsequently made to bear the stresses of body weight and muscle function.

The right side in Figure 48 also presents coxa valga with, as is usual, a perfectly straight neck. The socket curve and the circumference of the head run parallel, and neither ischium varum nor a thickened socket floor are convincingly present. Yet, the abnormally high position of the mesial edge of the femoral neck with regard to the foramen obturatum, the jockey-cap form of the femoral head and the depression (*"coup d'ongle"*) in the socket roof, as well as the lipping on its lateral border and perhaps also the (somewhat doubtful) lateral position of the lateral edge of the neck with regard to the lateral line of the os ilii, prove that an incongruence has existed between head and socket, which may also have played a part, by reason of the couple of forces, in causing the elevation of the femoral neck. This may at the same time have been the predisposing cause of the formation of the "chin" and of the horizontal position of the growth disc.

W. Müller believes the growth disc to be the cause of this—as of every—elevation of the femoral neck. He is of the opinion that "static and dynamic forces cannot possibly affect the form of a healthy full grown bone". This is in contradiction with everyday experience: the branches of the lower jaw, which form an oblique angle in the suckling, form almost a right angle when the teeth are present, and again an oblique angle after the teeth have fallen out. In fact, R. Volkmann has already described the *normal plasticity* of bone substance, and in our study on bone formation[7] we have tried to define the conditions for the development of such plasticity. In the slightly enfeebled skeleton, which we are now considering, this plasticity is increased in comparison with that of normal bone, with which the following chapter will deal. We are therefore of the opinion that the bone substance of the femoral neck, after having been formed, can indeed be elevated by the action of the couple of forces just as easily as growth can be retarded on the lateral side, so leading to a rotation of the growth disc under the influence of increased pressure acting there. Mechanically speaking, it only depends on the relative powers of resistance in the femoral neck as to whether the growth disc will rotate more, or the neck of the femur be more elevated.

The fact that in the wider socket on the left of Figure 48 coxa valga with an angular bend has developed, whereas a coxa valga with perfectly straight neck has developed on the right side, is attributable only to a difference in the intensity of the abnormal forces. And it should be noticed that this coincidence in the same individual is incompatible with W.

Müller's view. Why, indeed, should the coxa valga on the right side have had time enough to straighten out and not also that on the left?

Notice that the right neck in Figure 48 has two sets of trabeculae, which is in accordance with the larger area of contact between the head and the socket on that side. They cross at very oblique angles (See the normal in Figure 49)—this, as so many facts, being in contradiction with Cullmann-Meyer's crane hypothesis[7]—and being partly due to the fact that the neck is longer than normally. This increased length-growth of the neck raises the hypothesis that the joint resistance of the two systems of trabeculae has caused the acting forces to be optimal for the stimulation of growth.

Just as flattened hip socket is not the only cause for the development of coxa vara, so other causes for the development of coxa valga are to be admitted besides the action of the couple of forces brought about by flattened (wide) hip socket in slightly enfeebled bone. It is true that the forces which determine the normal position of the femoral neck cannot be considered to be all well known with certainty; but it may be assumed that the muscles running obliquely and transversely between the pelvis and the femur play a part in causing the femoral neck to grow in a mesial direction, and those running in a longitudinal direction cause it to grow in an upward direction, just as they normally stimulate the length-growth of the femoral diaphysis. The supporting bones, indeed, develop and grow against the pressure forces of function. If this be correct, every decrease of the transverse forces acting on the femoral neck may be expected to create a tendency of the neck to growth in the valgus position:—In *primary congenital anteversion of the femoral neck* part of the transverse muscle forces are used up in increasing the anteversion. The portion of the transverse forces which is left to act through the axis of the femoral neck is weakened and so a tendency of the neck to take on a more upright position is to be expected[13,18]. The well known tendency for coxa valga to develop in cases of *genu valgum* may have a similar cause; the adducted position of the

FIG. 50
E. M., female, aged ten.

FIG. 51
E. M., seven months later.

femora, while carrying the body weight, brings the origin and insertion of the transverse and oblique muscles running between femur and pelvis nearer together, thus diminishing their action. After *amputation of the thigh*, the rotators and adductors are weakened to an excessive degree, their movements after amputation usually taking place with a very small amount of force, and this may play a part in the development of a coxa valga in these cases. In conclusion we may refer to the coxa valga, easy to explain an generally understood, resulting from *total paralysis of the lower extremity*. There the pulling forces of the weight of the leg exercise their deforming influence on the atrophic bone.

Figures 50, 51, and 52 are taken from two out of six patients under our observation at present with slipping epiphysis. All of them are overcorpulent adolescents with symptoms of muscle weakness and some with a slight degree of knock-knees. All of them have coxa valga and flattened hip sockets! Figure 50 is of the same patient as Figure 51, taken seven months earlier. In both patients (See Figures 51 and 52) the right side shows a slipping epiphysis. On both sides the hip socket is too flat because of the thick socket floor, of which the lipping on the outer border of the socket roof and the depression (*"coup d'ongle"*) in the socket roof may be looked upon as the results.

A slight displacement of the right femoral head and irregularity in the structure under the growth disc announced in Figure 50 an impending slipping of the epiphysis, which occurred suddenly seven months later during walking (against advice), being accompanied by severe pain (Fig. 51). The outlines of the head and the part around the growth disc (Fig. 51) may be seen as two almost concentric rings, showing that the head has rotated about ninety degrees around a transverse axis; and experience[19] teaches us that this rotation takes place in a backward direction. The cause, both of the fracture and of the rotation, is to be traced to friction against the socket roof, brought about by collisions of the back of the femoral neck against the back edge of the hip socket while walking, at the moment when the leg is hyperextended. We have discussed this in Chapter II*B*, and mentioned that besides the valgus position of the femoral neck, the anteversion may have played a part in the causation of the condition.

FIG. 52
Fr. v. E., female, aged eleven.

At present we do not possess statistics showing the frequency of the coincidence of anteversion of the femoral neck

and coxa valga and slipping epiphysis. Nevertheless, the constant presence of anteversion of the neck in congenital hip dislocation justifies our hypothesis that it will also be found, though in a less degree, in congenital subluxation of the hip (*i.e.*, in too thick socket floor), whereas in the development of ischium varum no forces can be traced that might lead to the development of anteversion of the femoral neck (See Figures 7 and 8). Hence, a coxa valga which develops in flattened hip socket (a too thick socket floor) is, on account of the probable presence of anteversion of the femoral neck, more likely to lead to a slipping of the epiphysis than a coxa valga which develops in a wide hip socket (ischium varum). And this is all the more the case, since the varus position of the ischium implies a mesial displacement of the back wall of the socket, thus lessening the chance for the neck of the femur to bump against it. The fact that none of the cases of slipping epiphysis we have observed hitherto have an ischium varum, but all of them have a flat socket (*i.e.*, a thick socket floor), may tend to confirm this view.

In Figure 52 the displacement of the femoral head has not progressed as far as in Figure 51. The line of the growth disc has none the less a more curved course on the x-ray photograph, a sign that here also the rotation is about to take place in the same way as in Figure 51.

Thus coxa vara, the initial stage of coxa plana, and coxa valga are all exposed to the danger of displacement of the femoral head, and each in a special direction: coxa vara tends to a displacement downwards, initial coxa plana to a displacement laterally, and coxa valga to a displacement backwards. Every displacement necessarily causes serious circulatory disturbances in the femoral head and damage to the cancellous tissue of the neck underneath. After backward and downward displacement of the head, for obvious reasons weight-bearing is abolished or at least lessened. Only in the cases of lateral displacement full weight-bearing may be continued. And we seem justified in assuming that this is the reason why only after lateral displacement, serious flattening of the head and broadening and shortening of the neck are seen to develop.

In the above we have seen that coxa valga, when not complicated by slipping epiphysis, through the position of the femoral head and neck, offers a certain protection against deforming forces. At the same time, however, this increased resistance against deforming forces tends to maintain the incongruence of the joint surfaces, which, as Preiser has taught, leads to osteo-arthritis,—a condition which had, perhaps, better be termed "joint wear".

Figure 53 shows a wide hip socket (through ischium varum) on each side, on the left side more severely than on the right. The femoral necks are scarcely, or not at all, rotated (See the normal in Figure 49), although the widening of the hip sockets must have set the couple of forces $AP \times BC$ working. In the wider socket of the left side the greater changes are present, which approach nearest to those of coxa valga: the bone elements cross at very oblique angles; the neck is too long, so that the lesser

FIG. 53

trochanter is too low; altogether, below the tuber ischii (See Figures 51 and 52) the line joining the lesser and the greater trochanter crosses the diaphyseal axis at too oblique an angle. There is more than one depression (*"coup d'ongle"*) in the socket roof on the very small area where the femoral head transmits the concentrated pressure. Moreau[20], who has described these plural depressions in the socket roof, has observed that after a year their contour and the amount of lime salts had become more even. Hence they may be looked upon as the initial stage of a more even depression of the socket roof.

In the less wide socket of the right side the changes are less marked: the femoral head shows definite flattening and the socket roof a slight depression. Hence, here the right femoral neck behaves in a way we expected from a skeleton standing between the normal and one with slight feebleness of growth.

The patient is twenty-one years old. He is a wood cutter. He comes to us on account of pain in the right hip, in which reflex stiffness is absent. The fact that the femoral neck shows a suspicion of valgus position is a reason for us to assume a very slight feebleness of growth of the skeleton. The condition forms a transition to the conditions described in the following chapter; it is a *juvenile malum coxae.*

The left arm of the patient is dwarfed and shows dwarf fingers.

Elsewhere we have adduced grounds for the assumption that the too small foetal envelope may compress the flexible parts of the foetus, squeezing the blood either partly or wholly out of them, and thus condemn

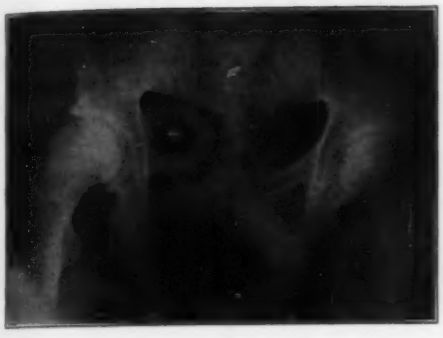


FIG. 54-A

FIG. 54-B

A. S., male, aged twenty-one.

them to dwarf growth, while the rest of the foetus continues its development. The dwarfed arm and fingers are in agreement with our view that the double-sided ischium varum may also have been brought about by smallness of the foetal envelopes.

(4) Malum Coxae in Flattened Hip Socket.

Figure 54-A shows a too thick socket floor,—*i.e.*, subluxation—or lateropositio coxae on both sides. There is not an evident ischium varum, but on the right side there is a convergence of the socket curve and the mesial edge of the ischium,—*i.e.*, a pointed pear-figure. Hence there is, besides flattening, a slight widening of the socket. There is not a convincing coxa valga (Fig. 54-B). The socket roof shows a very slight depression (*"coup d'ongle"*) and lipping, both of which phenomena are to be considered as results of the existing incongruence. The only indubitable change which the head shows on both sides is a slight flattening. The bone tissue here is twenty-one years old, hence much older than the bones in Figures 46 and 48, which are respectively eleven and one-half and fifteen years old, and has thus been exposed for many more years to the abnormal stresses inevitably resulting from a flattened hip socket, and yet the changes are less. On the grounds of these and other observations we come to the conclusion that normal bone, when exposed to the three groups of abnormal stresses attendant on flattened hip socket, does not as a rule lead to the development of coxa valga. The unenfeebled skeleton with flattened (wide) hip socket appears to afford a protection not only against the development of coxa vara and coxa plana but also against coxa valga. Thus the years of childhood of the unenfeebled with flattened (wide) hip socket will pass and mostly even those of adolescence, without any abnormal symptoms being observed. But here, as in cases of coxa valga, there is the threatening danger of joint wear, owing to the incongruence of the joint surfaces. In the course of years, the joint cartilage becomes too thin at the place of concentrated pressure; there we observe widening of blood vessels and absorption of lime salts[21],—*i.e.*, *plasticity of the bone* ensues, manifesting

itself in flattening of the femoral head and lipping, both at the edges of the femoral head and the socket roof. In short, in the course of years a condition of joint wear or osteo-arthritis develops in the flattened (wide) hip socket of the unenfeebled.

Figure 55 is the photograph of a thirty-seven-year-old patient; Figure 56 of a forty-five-year-old one. Both have flattened hip sockets on both sides. The symptoms are evidently worse in the older patient than in the younger one, and although we have not been able to follow the development of one and the same case with flat hip socket and coxa valga or simple flattening of the femoral head for many consecutive years, still it is probable that these figures represent different stages in the same process, and give an idea as to how the condition progresses in the same individual in the course of years.

The phenomenon of a double socket floor which has developed in the last two cases is interesting. The new floor is visible in Figures 55 and 56 as a tongue running inwards and downwards parallel to the mesial surface of the femoral head and separated from it by a narrow dark stripe. It starts at the upper edge of the fossa acetabuli, and may hence be compared to the lipping on the edge of the socket roof. Calot[22] mentions that three-quarters of a century ago Adams, in London, drew attention to the occurrence of a double socket floor and stated that the handle of a *bistouri* could be moved up and down between the old and the new socket floors. The double socket floor is a phenomenon not found in children, only appearing in later life. It is needless to say that the double socket floor fails to develop in cases of flat socket in which during childhood broadening and flattening of the femoral head and neck has brought about congruity of the joint surfaces. The double socket floor, however, appears to be unable to restore congruence of the surfaces of the joint (See Figures 55 and 56).

Hence, whereas slightly enfeebled bone with flattened hip socket leads to the formation of coxa valga, which during early childhood acts as a partial protection against further deformation through flat hip socket,

FIG. 55
E. v. S., female, aged thirty-seven.

FIG. 56
J. F., male, aged forty-five.

normal bone with flattened hip socket sustains still smaller changes in the femoral head and neck. Therefore, in both the slightly enfeebled and in the normal skeleton the incongruence between the femoral head and the hip socket is usually maintained till after adult age. This persistence of the incongruence is the very reason why with the more certainty in later years the condition of joint wear develops, which is known as osteo-arthritis, arthritis deformans, or "malum coxae", and which—as stated in the above—is characterized by the wearing away of the joint cartilage, plasticity of the femoral head and the upper portion of the hip socket, subsequent lipping at the edges of the femoral head and the socket roof, and often also by a double socket floor.

It seems only reasonable to assume that the stronger the bone, the later the joint wear will manifest itself. If this is correct, the juvenile arthritis deformans (Hoffa, Immelmann, Preiser), through flattened hip socket, must be considered as the outcome of the fact that the bone tissue is in a stage transitional between slight feebleness of growth and the normal condition.

Preiser[23], who first directed attention to the fact that incongruence of the joint surfaces in the long run leads to arthritis deformans, assumed the cause to lie in the fact that the part of the joint cartilage which is not in contact with the other joint surface becomes fibrous. Our opinion is just the opposite. In all the cases which we have treated by operation we have found a wearing away of the joint cartilage in the very area of contact between the joint surfaces, and slight unevennesses in those parts of the cartilage surfaces beyond the place of contact. Between these two areas there is a narrow strip of smooth and polished cartilage, appearing normal to the naked eye. Going from the area of concentrated pressure to the periphery of the femoral head, we thus find worn off, polished, and rough uneven areas of cartilage in succession. The lipping, which gradually gives the head the appearance of a mushroom, reminds one of the change of form of an iron rod, the end of which has been hammered. It is to be considered as the outcome of an abnormal plasticity of the layer of bone which lies directly underneath the cartilage. In fact, a section through such a femoral head (with joint wear or osteo-arthritis) along the axis of the neck may show broken trabeculae in the periphery of the cancellous tissue, the upper portion of which has obviously been elbowed aside by the central parts in their yielding to the concentrated pressure from the socket.

The double floor formation exceeds in extent the lip formation on the socket roof and on the femoral head. It raises the thought that the socket has formed new bone with a view to effecting a congruency. However this may be, the double socket floor seems the outcome of a tendency of the hip socket not to allow itself to be widened by a deforming femoral head, but, on the contrary, to adapt itself to the head.

It might seem preposterous that in the above the bone tissue of Figures 53 and 54 was assumed to be stronger than that of Figures 48, 50, and 52, although they all show signs of coxa valga. However, it should

be borne in mind that they all have a flat hip socket with a gap on the mesial side of the head, and that in the two first mentioned the changes are much less, even at a more advanced age. It might more justly seem open to doubt that the condition in Figures 55 and 56, where the subjects are respectively thirty-seven and forty-five years old, should have developed from one like that represented in Figures 53 and 54. However, the presence of a flat hip socket in them all and the fact that the serious changes in the skeleton shown in Figures 55 and 56 (narrowing of the joint line in the upper part of the socket, cartilage wear, considerable lipping) are exclusively found in adult age, along with the identity of the clinical phenomena, compel us to assume that arthritis deformans, or joint wear, such as Figures 55 and 56 exhibit, is one of the issues of flattened hip socket,—*viz.*, in the unenfeebled or normal skeleton.

When treating of coxa vara and of coxa valga we emphasized that these conditions may develop from other causes besides that of flattened (wide) hip socket, and the same is true also of malum coxae. We have observed some cases of this condition where there was not a flat (wide) hip socket, and where at operation we found cavities in the femoral head of the size of a pea or a small bean, which were filled with soft granulation tissue. For the development of these conditions "bland mycotic embolic processes" may be responsible, as Axhausen presumes. The development of malum coxae is not, like that of coxa plana, limited to a particular age. Where it is found in flattened hip socket, hence where abnormal forces have been working, we cannot leave these out of consideration without hampering the progress of our views.

If it may be considered an established fact that incongruity of the joint surfaces in normal (*i.e.*, unenfeebled) bone will lead to joint wear (arthritis deformans, osteo-arthritis), we may compare the various conditions discussed in this treatise as to the relative risk they run of being complicated in the course of years by joint wear. It is clear that coxa plana has the best chance of escaping this painful condition. Coxa plana is a kind of self cure of Nature of the congenital wideness (flatness) of the hip socket, the development of which explains the spontaneous disappearance of the complaints in patients with coxa plana. Coxa valga, on the other hand, runs the greatest risk of joint wear developing, just as coxa vara, inasmuch as the femoral head and neck remain able to carry the body weight. However, coxa plana as well may later be affected by joint wear or continue in this condition. In fact, the plasticity of bone is maintained as long as the pressure per unit of bone surface exceeds that which is required for the repair of the normal powers of resistance through deposition of lime salts. This repair may take place during a period of rest, even before congruity has been reached. Only when congruence and hardness develop simultaneously can the danger of joint wear be excluded, unless there has developed on the femoral head the typical pointed excrescence which fits in the fossa acetabuli, and is apt to give rise to abnormal friction during movements.

IV. CRITICISM FROM OTHERS

(Objections of Others to our Views)

The objections to the above conceptions made in the literature on the subject have, it is true, been limited to coxa plana, but they are directed against the grounds of our whole argument,—*viz.*, against the primary presence of a flattened (wide) hip socket.

Ingelrans[24] states that in his cases the hip socket is normal. G. Perkins[6], although agreeing that in coxa plana the hip socket is flat (wide), believes that ischium varum is "a late manifestation". O. Schreuder[25] states that in coxa plana the bony hip socket is indeed wide (flat), but, according to him, "from the anatomical preparations" and "from the widening of the joint line" in the x-ray photograph, it appears that a "cartilage swelling" is present, filling up the gap between femoral head and socket. He also states that ischium varum is "altogether secondary".

The opponents thus hold three different points of view:

(1) The hip socket in coxa plana is normal.

(2) The hip socket is flat or wide, but this is "a late manifestation", a secondary phenomenon.

(3) The increased width of the joint line is filled up with cartilage.

One of them (O. Schreuder) holds both the second and the third views. It is needless to say that if these views are based on valid grounds, they mean destruction to our conceptions. Therefore it is of importance to examine these grounds:

(1) P. Ingelrans writes, "*Nous ne saurions la discuter (c. à. d.,—la theorie de Murk Jansen), puisqu'elle suppose un cotyle anormal et que dans nos cas celui-ci est bien formé*". In the twenty-nine cases of subluxatio coxae and coxa plana which he presents, however, we find without exception a flat or a wide hip socket. We have therefore written to him personally to point this out, and in a friendly reply he has agreed to the said fact; but he has added that he believed the wideness (flatness) of the hip socket to be secondary. And in doing so he placed himself in agreement with the standpoint of

(2) Mr. Perkins, who believes he is able to prove that ischium varum is "a late manifes-

FIG. 57
Perkins' case.

tation", and that by means of x-ray photographs, which he generously lent us for the purposes of study and reproduction. Figures 57, 58, and 59 are reduced reproductions. They are of the same patient at intervals of eleven and five months respectively. Perkins sees and admits that the right hip socket is wide (flat) compared with the left one; but he believes that the flattening in Figure 57 is less than in the two following photographs. We have accurately drawn the outlines of the original (full-sized) x-ray photographs through transparent paper, yet we have not found any increase in the straightening of the socket line. In Perkins' case of coxa plana developing in the right hip (Figs. 57, 58, and 59), ischium varum was present (and wideness of the hip socket) from the initial stage of the condition, and it has maintained itself for sixteen months without a perceptible increase. Perkins' contention is, therefore, untenable; in his own case the ischium varum, —*i.e.*, the wide hip socket,—is not a late but an early symptom.

(3) O. Schreuder calls ischium varum an "altogether secondary" phenomenon, because Harrenstein[26] observed an increase of the varus position of the ischium in two patients during the development of coxa plana. During this time Harrenstein had allowed these patients to walk about in plaster which fixed the hip in a position of slight flexion and abduction. It is a well known fact that in patients with coxalgia who fix the hip in a position of flexion and abduction, the os ischii is also bent, in a way similar to that in ischium varum. In walking, these patients rotate the lower part of the pelvis backwards and upwards in order to lessen the trouble due to the flexion in the hip. Consequently, too backward (or too low) a portion of the acetabulum is made to transmit the pressure of the femoral head, and because of the abduction in the hip, moreover, a more mesial part of the acetabulum than normally is exposed to the pressure. Thus in the flexed and abducted hip the pressure forces are not directed

FIG. 58
Perkins' case eleven months later.

FIG. 59
Perkins' case five months later than Fig. 58.

against the facies auricularis sacri, as is normally the case, but backwards or mesial of it. Now just as a bending of the os ischii occurs in flexion and abduction through inflammation, it is to be expected in flexion and abduction through a plaster case. At any rate we are not justified in concluding that the bending of the os ischii, taking place in Harrenstein's patients in plaster, would have occurred as readily apart from the contracture position. O. Schreuder's ground for the assumption that the ischium varum "is altogether secondary" is thus untenable.

We have already said that in Perkins' case the "secondary" increase in the ischium varum remained absent during an observation of sixteen months. And the reason is patent: a patient with developing coxa plana does not walk with a flexed and abducted leg unless there be a contracture.

Moreover, in our case, shown in Figure 60, the ischium varum is present, and three years and three months later the same ischium varum is visible without having become worse (See Figures 61 and 62). And in our case illustrated in Figure 44, the ischium varum is present in the initial stage of coxa plana, and three years later (See Figure 45) coxa plana completa has developed without the ischium varum getting any worse,—*i.e.*, without further widening of the socket.

Ingelrans[27] supports his opinion that—sometimes, at any rate—coxa plana may develop in a normal hip socket, by publishing a case where, after a coxa plana on the right side, one also developed on the left side in a socket which, according to him, was normal beforehand[27]. Ingelrans will readily agree that the illustrations which he gives are not clear. We cannot say whether this depends on the roentgen tube used or on the reproduction. As far as our experience goes, we have been able to discover slighter changes in the structure of the hip socket, as well as in the femoral head and neck, since we have made use of Müller's tube and more recently of Philips' metalix. If we are nevertheless allowed to express an opinion about Ingelrans' reproductions[24], we must state that in his first photograph (Radiograph I, p. 25 *l.c.*) as well as in Radiograph II (p. 27 *l. c.*) the socket line runs too straight.

FIG. 60

FIG 61

The "cartilage swelling" "is patent", according to O. Schreuder[25], "from the x-ray photograph, which nearly always shows a widening of the joint line" (p. 24 *l. c.*). It is perfectly obscure on what grounds O. Schreuder feels justified to make out from an x-ray photograph that the widened part of the joint line is filled up by a "cartilage swelling" and not for example by fluid, fat, or connective tissue! In our Figure 45 we do indeed see that the widened part of the joint line of Figure 44 has disappeared in three years and ten months' time,—*i.e.*, it has been filled up by the enlarged head. We observe the same in Figure 59 relating to Figure 57 in the course of sixteen months' time, and the same in Figure 62 with relation to Figure 60 in two years and eight months' time. In these cases, therefore, the "cartilage swelling" would have disappeared again. This, however, is not in accordance with the nature of cartilage, which, on the contrary, develops and maintains itself with great obstinacy under the influence of sheering stresses.

Dr. Schreuder asserts that the presence of a cartilage swelling is patent "from the anatomical preparations". In a friendly correspondence with Dr. Schreuder about this subject, we learned from him that he takes for evidence of the existence of the "cartilage swelling" one preparation, described by F. J. Lang[28]. In Lang's illustrations of sections of the preparation, however, there is no question as to the existence of a cartilage swelling. In Lang's (unmagnified) Illustration 2, for example, the epiphysis appears to be thinner on the mesial side than normally. In this thin part of the epiphysis the strip of cartilage is indeed broader than higher up; but the bone below it is just as much narrower or is missing altogether. Hence, this is the mere outcome of the fact that the ossification at that place is less far advanced,—a phenomenon which growing bones often show when they are not exposed to functional pressure. In speaking of a cartilage "swelling" here, Dr. O. Schreuder has probably been misled by the enlarged illustrations which Lang gives in his publication, and in which a proper view of the whole femoral head is not possible.

FIG. 62

Moreover, in a case of coxa plana incipiens presented by Delchef[4], the "cartilage swelling" is missing. In an x-ray photograph made before death, the widening of the joint

line at the mesial lower side of head and socket is present. The cartilage layer, however, at the place of the broadening of the joint line certainly is not thicker than in the higher part, either in femoral head or in the socket floor. Finally, in opening the hip joint in cases of subluxatio coxae in order to obtain reduction, we have always found soft parts partly or altogether filling up the space and we have never found cartilage.

Thus all the reasons for calling the widening of the hip socket secondary, as well as all the grounds for assuming that the broadening in the lower part of the joint line is filled up with cartilage, appear to be invalid. On the contrary, in our cases the flattening (widening) of the socket is present before the broadening of the femoral head (Fig. 44), and it remains stationary for years while coxa plana is developing in the socket. And this is compatible only with the conception that flatness (wideness) of the hip socket is primary to the changes of the femoral head and that flatness (wideness) of the socket need not even be increased by the latter, unless a contracture position has been brought about by the action of muscles or is imitated by a plaster dressing. If the sequence of events were different,—if, for example, the changes in the femoral head were indeed primary —they ought to have been present in our cases before the thickened socket floor or the varus position of the ischium.

The other objections raised to our view do not touch the fundamental questions. They only prove that the writer has not taken into account either the various acting forces or the various degrees of enfeeblement of the skeleton. So Perkins believes that the fact that besides coxa plana other conditions may develop in flattened hip socket is a reason for refuting our views. In discussing Figure 14, a case of Perkins', we said that the opposite was true, and that the position of the point of contact between the femoral head and the flat socket, lying in the continuation line of the axis of the neck, must lead to a symmetrical flattening of the head; and that this symmetrical flattening at the same time prevents the rotation of the head to the horizontal position, which in its turn would otherwise lead to the development of coxa plana. Hence in Figure 14 the behavior of the bone is in perfect agreement with our views regarding the acting forces. If a coxa plana had developed there, our view would have been subversed. Perkins, moreover, believes that the occurrence of coxa fracta in the flattened hip socket of a case of his (See his Figure 9, which perfectly resembles our case of Figure 41) would disprove our view. In connection with this we may refer the reader to our argument on page 498. Furthermore, Perkins' question as to why a child with spasm of the hip muscles, lying on an abduction frame and hence not walking, can still develop coxa plana, may be sufficiently answered by saying that the cramp of the muscles may yield the abnormal stresses which we consider to be responsible for the development of coxa plana. And lastly, the answer to his question as to why coxa plana more often develops between the third and the tenth years of life will be found in the foregoing chapters.

The rotation of the growth disc to the horizontal position demands a relatively long period of time, as also for the formation of knock-knees.

Finally, Dr. Harrenstein also believes he has raised objections to our views. However, nowhere does he discuss the sequelae of primary incongruence between the hip socket and the femoral head, which constitute the essence of our argument.

Summarizing, we must state that the actual facts which have been brought forward for refuting our views have either proved to support our views, or failed to touch their essence.

V. CRITICISM OF OTHERS
(Our Objections to the Views of Others)

In the first three chapters of this treatise we have tried to sketch the etiology as well as the pathogenesis of coxa vara, coxa fracta, coxa plana, coxa valga, slipping epiphysis, and malum coxae, and in the fourth we have tried to show that the objections brought forward against our views are unfounded. Now we purpose to present our objection to the views of others. The chief of these are:

(1) All those who have written on the subject fail to disclose the reasons why the above mentioned hip anomalies so often coincide, either in the same subject or in the same family, with congenital dislocation of the hip, with spina bifida (occulta), club-foot, and other congenital malformations.

(2) A number of authors have, it is true, directed attention to the relationship between two or more of the above mentioned conditions (Froelich, Nové-Josserand, Tillier, Calot, and others). Many have also raised an hypothesis about their etiology. However, all have failed to trace the pathogenesis, so that not one has taught us to understand the mechanism of the development of any one of these affections, nor the conditions under which now coxa plana, then coxa vara, or one of the other above mentioned affections comes about.

The greater number of the considerations proffered on the subject are limited to the etiology of coxa plana. And it is striking that these are again limited,—namely, that they are chiefly or exclusively restricted to the search for a cause of the flattening and fragmentation of the femoral head with or without reference to the thickening of the neck.

(3) Not one writer deals with the cause of the other changes,—the rotation of the head and the conditions causing it, the jockey-cap form and the lateral displacement of the femoral head, the plasticity of the neck, the formation of a "chin" on the neck and the scarcity of lime salts in it, the ensuing bend in the growth disc, the characteristic age (3 to 10 years) and the more frequent occurrence in boys than girls. Hence, the opinions about the etiology of coxa plana found in the literature on the subject cannot be claimed to be termed theories, but can be merely designated as hypotheses, since their authors have failed to collect the symptoms.

Coxa plana, then, is considered by the various authors to be due to circulatory disturbances, trauma, inflammation, rickets, an unknown disease, a congenital disturbance of ossification, and changes of the endocrine glands, either separately or in different combinations.

(4) The great objection which may be finally brought forward against all these hypotheses is that the writers have presupposed without any proof that a femoral head which is softened by one or more of the above mentioned causes can be flattened in and by a normal socket. A flattening of the head, indeed, could only take place if the socket at the same time allowed itself to be widened by the softened head. One could imagine that a softened femoral head should partly or altogether press away the fatty tissue and even the ligamentum teres without, however, widening the socket, and in so doing should form a somewhat conic protrusion fitting more or less accurately into the fossa acetabuli, such as is frequently observed on the femoral head in malum coxae. However, this condition should not be identified with coxa plana, so that all who proffer the hypothesis that softness of the femoral head, through whatever cause, will lead to coxa plana, fail to bring forth evidence for the assumption that primary softening of the femoral head can lead to secondary widening of the normal hip socket.

We will now discuss each of these hypotheses separately:

DISTURBANCE IN THE CIRCULATION RESULTING FROM TRAUMA

In his first publication in 1910, Legg brought forward the suggestion that coxa plana might be caused by disturbance in the circulation as a result of trauma. A trauma, according to him, shuts off the blood vessels which go from the femoral neck to the epiphysis at the level of the growth disc. The shortage of blood in the epiphysis would necessarily lead to a flattening of the head through the pressure of the body weight. The disturbance in the circulation would lead to an extra flow of blood to the neck. This would lead to a thickening of the neck. The four figures of Legg's earliest cases all show an evident ischium varum. If Legg had known the mechanical effect of this on the femoral head and neck, he would have realized that the resulting width of the hip socket was reason enough for a trauma, as well as for the flattening of the head, as we have tried to explain in Chapters II and III. Legg, however, has had an external trauma in view—a fall or a jump.

Allison and Moody[29] and also Pommer believe that circulatory disturbance resulting from trauma is the cause of coxa plana, as does also Erwin Schwarz, Perthes' assistant, who carefully examined fifty-five cases (44 boys and 11 girls), while Perthes[30] believes that not only trauma with injury to the blood vessels, but also an "*infection attenuée*" (light infection) may be the cause of coxa plana. Waldenström is of the same opinion.

Calvé[31], too, believes that circulatory disturbance in the femoral head is the cause of coxa plana, and that both infection and trauma may bring

about this condition. He takes trauma in the broad sense of Erdberg, such as repeated knocks at the limits of the normal motion. In so doing he makes it all the more difficult to understand why so many hips remain normal under the influence of identical traumata.

The facts, however, do not justify the assumption that trauma is the cause of coxa plana. Legg has been able to trace a trauma in sixty-six per cent. of the cases; Ingelrans in thirty-one and twenty-five one-hundredths per cent. There still remain thirty-four per cent. and sixty-eight and seventy-five one-hundredths per cent., respectively, of the cases in which a trauma is not to be traced. Ingelrans[32] has observed the development of coxa plana on one side after a fall on the other leg. On the side on which the fall occurred, no coxa plana developed. Besides, every one knows that boys and girls will often jump and fall without getting coxa plana. Those who, nevertheless, insist on assuming trauma to be the cause of coxa plana are under the obligation of giving the reasons why in so much larger a number of cases coxa plana fails to develop after trauma, and why it does develop in thirty-four to sixty-eight per cent. of cases without a previous trauma. Trauma may be conducive to the development of coxa plana; the figures justify this assumption. However, certain changes in the hip joint appear to be a *conditio sine qua non.* Calvé finds "the light space in the joint constantly enlarged". Hence, he finds the flattened (wide) socket a constant phenomenon just as well as we do. And Chapters II and III of this treatise may have furnished sufficient evidence for the assumption that the flattening (widening) of the hip socket constitutes the internal cause of the trauma which the above mentioned investigators assume to be of external origin.

Summarizing, besides the four objections made in the above to the view that coxa plana is caused by trauma, we proffer a fifth objection,—*viz.*, that coxa plana often occurs without a preceding trauma, and traumata with an infinitely higher frequency fail to cause coxa plana.

CIRCULATORY DISTURBANCE THROUGH EMBOLISM

Axhausen[33] has brought forward conclusive proof to justify the assumption that circulatory disturbances play a part in the development of coxa plana, which Legg had presumed as early as 1909. Axhausen found the femoral head necrotic in a case of coxa plana and broken into pieces by pressure. The pieces had scraped against each other, thus producing fine bone powder between them. Axhausen has entirely neglected to study the changes in the hip socket. Nor has he observed the lateral displacement of the femoral head which is an undeniable cause of circulatory disturbance. Therefore he cannot find an explanation for the cessation of the blood supply to the femoral head and is hence compelled to assume "bland mycotic embolic processes" to be the hypothetical cause of the condition. This hypothesis, however, does not coincide with the facts. Why should emboli occur exclusively between the third and tenth years of life? Then,

how could coxa plana be reconcilable to perfect health of the children? Why should not other joints be affected in the same way? Why should the femoral neck also become wider and shorter, if merely the blood supply to the head is cut off? Why should these "bland emboli" preferably occur in hip sockets with a thickened floor or with ischium varum? And finally, why should the other side as a rule show changes like coxa plana incipiens, coxa vara, coxa valga, or even congenital hip dislocation? In short, however valuable the pathological anatomical findings of Axhausen are for the knowledge of coxa plana, his hypothesis that emboli bring about the condition furnishes a ground for only a single symptom,—*viz.*, the death of the femoral head. Axhausen's hypothesis is either in contradiction to the other characteristics of the clinical picture, or it fails to give their cause. Moreover, the four objections mentioned on page 520 are also applicable to his hypothesis. Therefore it cannot be accepted as valid.

INFLAMMATION

In 1916, F. C. Kidner[34] published a case of coxa plana in which he "curetted a soft greyish-red material" from which a "staphylococcus aureus of low vitality" had been cultivated. He concludes from this that the condition is a "mild infection of hematogenous origin". In July, 1926, Kidner[10] published a case of coxa plana from which he had removed—also during biopsy—two pieces of bone and cartilage from the head, neck, and growth disc. Phemister[35], who made a microscopic examination of these pieces, stated that "the findings favor the view that the condition is the result of circulatory disturbance and they speak against inflammation". Nevertheless, Phemister, with Kidner, believes in inflammation as the cause. A. H. Freiberg[36] found 12,000 leucocytes in a case of coxa plana. He, too, adheres to the inflammation hypothesis. However, these three authors do not exclude other causes, and believe that coxa plana may also be due to trauma or malnutrition.

Do the facts really justify the assumption of infection being the cause of coxa plana? In 1924 Ingelrans reports about ten cases in which bacteriological examination had been carried out. The result was positive in three of them,—*viz.*, in Kidner's case, in a case of Legg's, and in a case of Phemister's, and staphylococcus aureus was found. If we add to these Kidner's case of 1926, then out of eleven cases of coxa plana, infection has been found three times and found to be absent in eight cases. So, concluding from this that coxa plana is the result of infection does not seem justified, all the less since the ubiquity of staphylococcus aureus opens up a possibility of its presence even under careful precautions of asepsis. None the less, in all cultured countries a number of writers have adopted the inflammation hypothesis. In Italy, Uffreduzzi[37], Donati, Rinaldo, Galeazzi, Micotti incline to consider not only coxa plana but also coxa vara, coxa valga, and malum coxae as results of infection, in which a trauma acts as a revealer (*révélateur*). In Belgium, Delchef[38], Delcroix[39], Moreau[20]

are adherents of the inflammation hypothesis. Froelich[40], in France, calls coxa plana as well as coxa valga an inflammation, probably infectious, although the infectious element is only *"décelé"* by way of exception. Bohème[41], in his thesis written under the supervision of Froelich, calls coxa plana a coxofemoral epiphysitis of growth (*épiphysité coxofémorale de la croissance*). Mérine defends the inflammation hypothesis: according to him, the inflammation is situated in the bone of the epiphysis, and remains limited to that center because of its being surrounded by a layer of cartilage. In England, H. Platt supports the inflammation hypothesis. All these writers say, as it were with Sorrel, "If coxa plana is never or at least not always of traumatic origin, it can hardly be anything else but of inflammatory origin."

In fact, grounds for assuming infection are missing where only three out of eleven cultures have yielded bacteria, and then only staphylococcus aureus. And with this hypothesis a cause only for the plasticity of the femoral head and neck is produced, while all the other symptoms of coxa plana remain either in obscurity or appear in contradiction to the infection theory[42]. Legg asks, rightly, "If infection is the cause of coxa plana, why do we never see the symptoms of an acute coxitis, accompanied by fever and leucocytosis? Why do we not also find multiple infections in other parts of the body? And why does the generally recognized inflammation of the hip never show the characteristic flattening of the femoral head?" And we add: Why is the infection limited to the third to the tenth years? Why is it compatible with perfect health? Why does not a similar flattening occur in other joints? Why, moreover, is the hip joint on the other side regularly affected, be it mostly to a less degree? The infection hypothesis cannot supply an answer to any of these questions. And over and above that, the four objections made on page 520 are applicable to the infection hypothesis. Thus, the infection hypothesis is only of value inasmuch as it has given occasion to bring forward evidence showing that coxa plana is not dependent on infection, but that another cause has to be assumed.

It is patent that coxa plana may be complicated by infection. The dead material in the femoral head and the traumatized cancellous tissue in the femoral neck offer a better medium for growth to eventual bacteria circulating in the blood than living and undamaged tissue does. And such a complication is not rare. However, when it occurs we observe the characteristic reflex stiffness and usually also a disturbance of the general condition, neither of which is inherent to uncomplicated coxa plana. On the other hand, an infection outside the hip joint (inflammation of the lungs or any other illness) has proved to be able to enhance the risk for development of coxa plana, or to accelerate its development. The preceding pages have furnished grounds for assuming that in such a case the illness may have brought about a degree of feebleness in the child sufficient to cause the growth disc in the femoral neck to rotate into the horizontal position, and so to create the possibility for a lateral displacement of the femoral head.

Some writers (Froelich, Bohème) not only call coxa plana and coxa vara inflammatory, but also the many changes of other epiphyses, apophyses and metaphyses and thickenings of cancellous tissue, such as are observed in the navicular bone of the foot and in the vertebrae. These conditions, however, lie outside the limits of our present considerations. None the less, it may be noted that these writers omit to adduce reasons justifying the assumption "inflammation".

RICKETS

Schulthess[43] wrote, "The process (growth disturbance) in coxa plana is doubtless one located in the epiphysis, and if we should have to classify it under one or another disease we should do so under rickets". Rickets as such, however, does not give rise to the development of coxa plana, as is proved by the fact that the majority of rachitic children remain free from coxa plana, and also the fact that rickets is a preeminently symmetrical condition, whereas coxa plana seldom occurs to the same degree on both sides. Hence at least one more factor has to come into play and to be made responsible for the asymmetry, and that is just the one that is being looked for. Whereas all other writers on the subject trace the cause exclusively to a local injury, Schulthess finds the cause of coxa plana exclusively in the condition of the skeleton. A combination of these two is suggested by Fromme[44], who believes that trauma, infection, and circulatory disturbance associated with rickets may lead to coxa plana. In Chapters II and III we have tried to determine the share of rickets in the development of coxa plana. We saw that coxa plana may indeed develop in the rachitic,—*i.e.*, in cases of severe feebleness of growth,—provided a flattened (wide) socket is present for procuring the internal (chronic) trauma; but that in a case of rickets, coxa vara is more apt to develop, whilst the chances for the development of coxa plana are greater in cases of moderate feebleness of growth. With regard to the part played by trauma, infection, and circulatory disturbances mentioned by Fromme, we may refer to the foregoing pages.

AN UNKNOWN DISEASE

Nové-Josserand hesitates between two hypotheses: either coxa plana is a new, perfectly autonomic disease of which we shall sometime in the future know the cause, or it may be that some people have an abnormal bone tissue that reacts in a special way to traumata or infections which in other people would do no harm whatever, or bring about the ordinary result[45]. Before thinking of "abnormal bone" which reacts to traumata in a special way, it is necessary that the reactions of normal bone, as well as of enfeebled bone so often met with, should be studied. And in Nové-Josserand, as in other investigators, we miss the study of the reaction of bone to simple mechanical stimuli. The application of two of the rules which have been found for this will make this sufficiently apparent,—

viz., (1) enfeebled bone shows sooner than normal bone decrease of growth to increase of pressure,—the phenomenon that, for example, becomes manifest in the rotation of the growth disc of the femoral neck into the horizontal position, and that occurs the more rapidly and the more completely, the more the bone tissue is enfeebled; (2) excess of pressure on bone may lead to traumatic or repair plasticity of cancellous tissue,—the phenomenon which becomes manifest in the broadening and shortening of the femoral neck in coxa plana, after the horizontal femoral head has been displaced sideways and by that displacement both the femoral neck and the head have been injured. These rules should be applied to the reaction of enfeebled, especially injured bone, before the assumption of an "unknown disease".

CONGENITAL ABNORMALITY IN THE UPPER FEMORAL END

In 1915, Delitala[46] expressed an opinion that the cause of coxa plana should be looked for in a congenital abnormality, either in the growth cartilage or in the bone nucleus of the upper femoral end. About the year 1924 he writes[47] that the bone nucleus in the femoral head persists partly as cartilage, and he cites a case of coxa plana in which some cartilage persists at the junction of the ischial and pubic branches. Tillier[48] also believes that a congenital malformation of the epiphyseal nucleus is to be made responsible for the development of coxa plana, and Zaayer[49] assumes the congenital presence of several bone nuclei in the femoral head to be the congenital cause of coxa plana. Mérine objects that the changes in the femoral head become manifest only some years after birth, and that in those cases which have been observed before the onset of coxa plana, an absolutely normal femoral head has been observed in one case of Lamy's and in one of Mérine's himself. To these we can add a third case of Sorrel's, a fourth of Waldenström's, a fifth of Ingelrans', while, moreover, our Figures 44 and 45 illustrate what may be regarded as a sixth case observed by ourselves, in which the femoral head showed only a single bone nucleus before the onset of coxa plana. Besides, Legg reports that after the publication of Delitala's first article he made roentgenograms of the whole skeleton in a number of cases of coxa plana without finding a suspicion of a congenital anomaly in any one of them.

Thus the hypothesis of congenital abnormalities in the femoral head being the cause of coxa plana has been of utility in that it has led to investigations which have resulted in excluding them as a cause of coxa plana. Those who still tend to adhere to this hypothesis may remember that, moreover, the four objections brought forward on page 520 are of avail against this hypothesis.

ENDOCRINE DISTURBANCES

Disturbances in the ductless glands have also been made responsible for coxa plana as well as for slipping epiphysis, as they have been for so many

conditions. The fact, however, that these glands have a symmetrical effect, and the above mentioned conditions are hardly ever symmetrical, would make it necessary to search for one more factor which is responsible for the asymmetry.

The views of Calot demand a separate discussion: with admirable enthusiasm, eloquence and lucidity Calot, in numerous writings since 1921, has defended the opinion that coxa plana is always a disregarded subluxation (*"une subluxation méconnue"*),—*i.e.*, that it always develops in too flat a hip socket, hence in a socket with too thick a floor. This very nearly conforms to our conception, so that Calot's name and ours are often mentioned together in the literature on the subject, and it has even been suggested that our views have been derived from Calot[50]. This is not the case: We have formed our opinion independently of Calot and as early as the year 1918* we made it known in meetings, and afterwards in lectures and writings. Our opinion differs from that of Calot on the following points:

(1) Calot assumes only subluxatio coxae as the cause of coxa plana, —*i.e.*, a flattened hip socket, a condition with too thick a socket floor, but not a wide socket caused by ischium varum or by a V-shaped pear-figure.†

(2) Calot believes that coxa plana occurs when the socket roof is sloping upwards, in a *"cotyle à demi-citron"*, not in a *"cotyle à demi-orange"*. We believe that the shelving of the socket roof, at least if it exceeds certain limits, forestalls the development of coxa plana (See pages 474 ff).

(3) Calot limits himself to the study of the etiology of coxa plana, ascertaining a *"cotyle à demi-citron"* in every case of coxa plana he encounters; but he fails to trace the pathogenesis of this as of the other phenomena. Hence he omits to study the changes in the stresses which flattened hip socket entails in the non-fitting femoral head and neck. Moreover, Calot omits to demonstrate the way in which flattened hip socket is connected with the numerous alterations in the form of femoral head and neck.

(4) Calot omits to take into account the various degrees of enfeeblement of the bone substance, and so fails to show how the same degree of flattening of the hip socket may and must lead to various deformations of femoral head and neck in different cases.

(5) Calot assumes "a medullary or cerebral dystrophy" to be the cause of the deformation of the hip socket, as well as of congenital hip dislocation. He supposes a change to be present in the hip joint which is analogous to that of the arthropathies in tabes dorsalis. Hence, this is opposed to our view, according to which, in conformity with LeDamany's investigations, flattened and widened hip socket as well as congenital hip dislocation are brought about by simple mechanical forces acting on the foetus.

*See Introduction.

†In one of our lively and pleasant discussions (in 1925) we directed Calot's attention to this difference, and pointed out that, for example, the first figures of coxa plana represented by Legg clearly show a widened socket (through ischium varum) not a flattened socket (through thick socket floor).

For all that, Calot has contributed more than anyone else to establish the view that all hip sockets with coxa plana—and during the last few years also even those with coxa valga and malum coxae—which have been represented as normal in the literature on the subject, show characteristic changes of flattening (or widening) of the socket. And he may have made enemies by so doing, but we cannot refrain from paying him the tribute of our homage for thus substantiating his conviction.

Summarizing, we find that the various investigators, in searching for the cause of coxa plana, have limited themselves to tracing the cause of a single, the most obvious, symptom of the condition,—*viz.*, the softness of the upper femoral end. The numerous other phenomena, such as rotation of the femoral head to the horizontal plane, the "jockey-cap" form, the lateral displacement of the head (head-in-neck position), the "chin formation" on the inner side of the neck, the mesial gap between socket and head, the depression (*"coup d'ongle"*) in the socket roof, are either not mentioned, or not taken into account in the explanation given. All hypotheses proffered to explain the softness of the femoral head—circulatory disturbances, trauma, inflammation, rickets, an unknown disease, congenital anomalies of the femoral head, endocrine disturbances—either taken separately or in the most diverse combinations, fail to give a cause for the above mentioned phenomena, or are even incompatible with them. And the same holds good for the changes accompanying coxa plana (either in the same individual on the "normal" side, or in other members of the same family), the stadium incipiens of coxa plana, coxa vara, coxa fracta, slipping epiphysis, malum coxae, as well as for the congenital changes (dislocation of the hip, spina bifida, club-foot, and other congenital malformations) with which all these conditions are more frequently associated than normally. Only for the assumption of circulatory disturbances grounds have been adduced,—*viz.*, by Axhausen, W. Müller, Phemister. However, the assumption of an external trauma as well as of emboli and bacteria as causal agents would be opposed by clinical facts. We have, on the contrary, been justified in assuming an internal trauma as a causal agent of coxa plana, because the ever present flattened (widened) hip socket may bring about the slow rotation and the lateral displacement of the femoral head and together with it the circulatory disturbances in it. Displacement of the femoral head means injury to the cancellous tissue in the femoral neck, and subsequent traumatic or repair plasticity. By assuming too small foetal envelopes to be the cause of flattened hip socket, we understand why in coxa plana the "well" side is regularly affected; why coxa plana often occurs in many members of the same family and does not only alternate in the same family with the other sequelae of a flattened hip socket, the nature of which is determined by the greater or lesser degree of feebleness of growth of the skeleton, or the intensity of the acting forces; but also alternates with congenital malformations of other parts of the body which, like flattened hip socket, are in their turn caused by the limitation of space brought about by too small foetal envelopes.

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FRACTURE OF THE SACRUM

Report of One Case

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CASE REPORT

P. E., colored male, age twenty-six, entered Rush's Infirmary November 14, 1928, because of injuries received two weeks previously when he overturned in a speeding automobile. He did not know just how the accident occurred. For three days following the accident he had been confined to bed, but since that time had been able to walk by supporting himself with a cane. He showed no evidence of paralysis, and sensation in the legs had remained normal. When weight was borne on the left leg a dull ache was experienced in the left sacro-iliac region. The left leg was rotated slightly inward. The wing of the left ilium was more prominent than the right and a depression could be felt in the region of the left sacro-iliac joint. Pressure over this region and over the symphysis pubis caused pain. Flexion of the left thigh caused a severe lancinating pain, the exact position of which he could not describe, but it seemed to be near the superior ramus of the pubis.

X-ray plates made in stereo showed fractures of both rami of the left pubis, the body being torn away from the symphysis and displaced backward and downward. The ischial portion of the innominate bone seemed to be displaced inward, while the ilium was pulled outward, giving the left innominate bone the appearance of being twisted on the sacrum. The left sacro-iliac joint was torn partly open. A transverse fracture was present, beginning just to the left of the body of the first segment and passing laterally to the sacro-iliac articulation. The fragment was displaced upward. Beginning at this fracture line, just lateral to the first sacral foramen, a longitudinal fracture passed downward extending through the third segment, there reaching the lateral border. This fragment was displaced backward with the ilium, the body of the sacrum being displaced forward into the pelvis.

The patient was placed in the pelvic hammock with traction upon the left leg for two weeks. At the end of this time simple recumbent treatment was instituted for two more weeks. On the thirtieth day the patient left the hospital. Walking caused no pain and the gait was normal. A radiograph made on this date showed the position of the pubis to be improved, the ilium partially returned to its natural position, and the fracture of the sacrum unreduced.

A review of the literature shows that fracture of the sacrum is exceedingly rare, and when it occurs it is usually the result of violent trauma. Until the present time only twenty-eight cases have been reported. In 1896 Briche tabulated eleven cases. Schereschewski, in 1912, collected eighteen cases from the literature, and since that time ten more have been added.

TYPES OF SACRAL INJURIES

Cotton in his book on fractures and dislocations contributes the following paragraph on sacral fracture: "Sacral fracture is one variant in this general class of injury of the pelvic ring. It occurs but rarely. The fracture is in approximately vertical line close to the sacro-iliac joint. So far

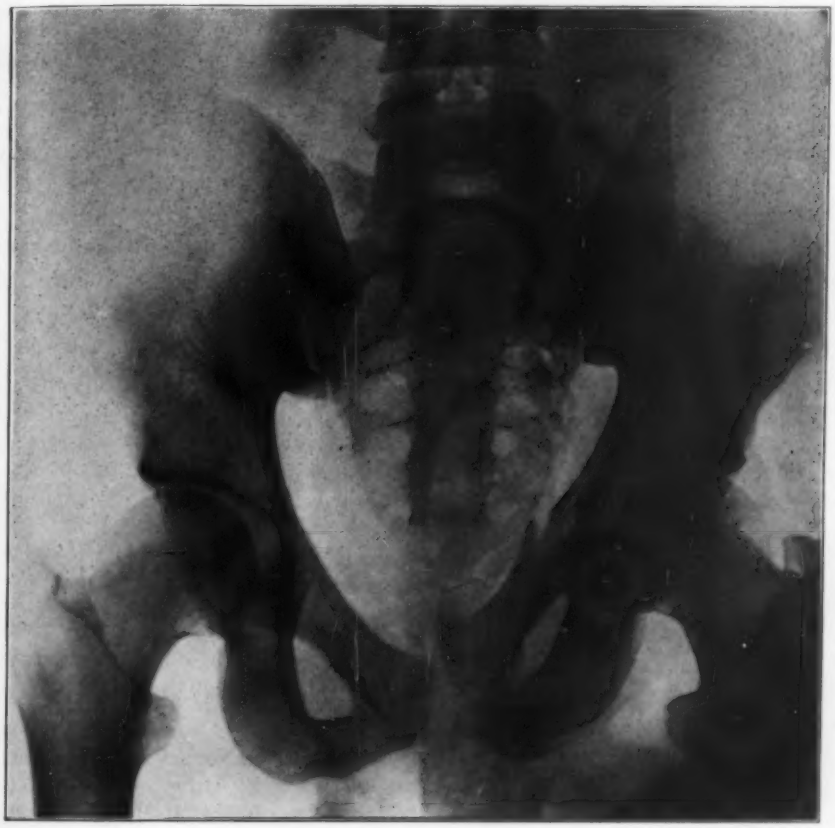

FIG. 1
Skiagraph two weeks after injury.

as published data go, it seems to have no direct signs by which it may be distinguished from fracture of the ilium just on the other side of the joint, and it seems to differ in no way as regards prognosis."

Roentgen-ray studies reveal an increasing number of incomplete cracks and fissures of the sacrum. Oblique fractures are exceedingly rare. Transverse fractures may involve the upper or lower portion of the sacrum, and are usually due to sudden, swift traumatism from behind, as the kick of a horse. The usual displacement is that of the lower fragment forward into the pelvis with the line of separation just below the sacro-iliac joint. Displacement may be entirely absent or slight. According to Chipault there is more severe traumatism in fractures of the upper sacrum than in the lower, but the symptoms are less severe and the inter-fragmentary depression is less evident, as the inferior fragment is not so much displaced. Dislocation of the sacrum from opening of the sacro-iliac joint is rare and caused by great violence. Other injuries often accompany them and most cases are fatal.

SIGNS AND SYMPTOMS

The clinical picture in sacral fracture is usually that of pain in that region and the presence of bony deformity, plus the signs and symptoms of complications. There may be interference of bladder and rectal functions. Vaginal or rectal examinations may reveal extreme tenderness over linear cracks. Coughing, defecation, or even breathing may be painful. If complete dislocation is present, there may be paralysis of the bladder, rectum, and legs from injury of the sacral plexus, and in certain fractures the nerve injury may correspond to that present in dislocations. Soft parts over the sacrum may be severely bruised or even slough. Other symptoms may be present, dependent upon the degree of damage to the intrapelvic viscera.

According to Tuffier, in fracture of the upper portion of the sacrum the nerve roots injured are the coccygeal, the first, second, third, fourth, and fifth sacral, and perhaps the fifth lumbar. The motor disturbances involve the sphincters and the muscles of the foot and leg. The sensory disturbances involve the genital and gluteal regions, the posterior surface of the thigh, and the leg and foot to a variable extent.

In 1889 Tuffier described the case of a woman, thirty-four years of age, who fell from the fourth floor of a building. Her legs were paralyzed; there was anaesthesia of the limbs, also retention of urine and constipation. After a time spasmodic attacks associated with pain developed in the lower limbs, and there was muscular atrophy. Four years later a pregnancy went on to a normal termination. During the fifth year Tuffier again examined the patient who then complained of lancinating pains in the legs and ulceration of the right foot. Rectal examination revealed evidences of the old fracture which had never been reduced and which had resulted in a greater displacement toward the right than to the left. The patient walked with difficulty. Anaesthesia to pricking was found on the posterior surface of the thighs, the lower half of the external surfaces of the legs, and the dorsal surfaces of the feet. These disorders were symmetrical. Sensibility to touch and temperature was also disturbed at these points.

TREATMENT

In uncomplicated cases where displacement is absent or slight, simple recumbent treatment alone for two or three weeks is sufficient. In fracture with displacement, reduction should be accomplished by digital pressure within the vagina or rectum if that can be done, and the patient placed upon a water bed or Bradford frame with soft pads to avoid pressure necrosis in the skin over the sacral region. Attempts to pad fragments into position by a rectal or vaginal packing are usually not successful, cause great pain, and are apt to cause a necrosis of the part packed. In complicated cases operative procedures,—such as the removal of depressed fragments, repair of the rectum or other intrapelvic damage—may be indicated. In

some fractures of the sacrum with associated fractures of other portions of the bony framework of the pelvis, and, most particularly in dislocation due to opening of the sacro-iliac joint by displacement of the ilium outward, the pelvic hammock seems to have a definite indication.

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ACUTE OSTEOMYELITIS OF THE SPINE

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Acute osteomyelitis of the spine is a disease which should be more widely recognized because its early diagnosis is vital to the patient, yet the diagnosis is often extremely difficult, and is sometimes impossible. The case presented herewith seemed of the latter type, and is reported on that account. In this case the deep abscess was drained fairly early. This procedure undoubtedly saved the patient's life, and it apparently also saved the osteogenetic layers of the periosteum. A new vertebral body sufficient to prevent deformity or paralysis was formed. The roentgenograms showed a normal spine at first, and complete obliteration of the body of the vertebra one month later. Five months after onset, exuberant reformation of the vertebra was present; and ultimately solid fusion of the adjacent vertebrae without deformity obtained.

CASE REPORT

This case was seen with Dr. H. W. Allen of Minneapolis, who called the writer in consultation four weeks after onset.

FIG. 1

July 22, 1925. Lumbar spine and sacro-iliacs normal.

The patient, a boy of nineteen, was first seen by his physician on July 21, 1925, because of backache and fever. His past history was negative except for pertussis, varicella, measles, and parotitis in childhood, and a tonsillectomy at fourteen years of age. His present illness began two days previously, with backache following heavy work (lifting cement blocks). After swimming the next day, he was seized with chills and fever. When first seen by his doctor, the patient complained of stiffness in his back, with backache, and pains radiating down the backs of both thighs. At this time the temperature was 101 to 102 degrees, and the leucocyte count was 26,900. The urinalysis showed albumin, hyaline, and granular casts, an occasional red blood cell, and two pus cells per high-power field. Temperature continued high for nearly a week and the leucocyte count rose to 28,700.

On examination at this

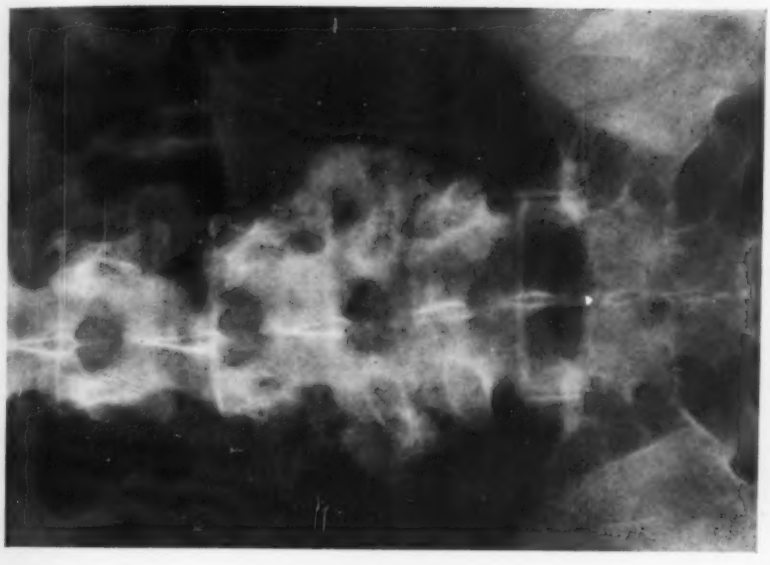

FIG. 3

Jan. 6, 1926. Showing exuberant callus replacing the destroyed fourth lumbar vertebra.

FIG. 2

Aug. 26, 1925. Showing nearly complete destruction of the fourth lumbar body.

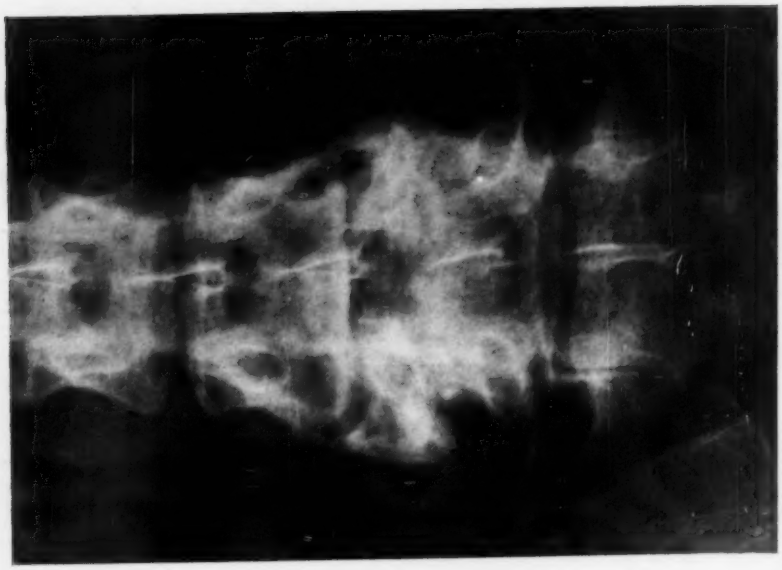

FIG. 5
Oct. 20, 1927. Showing strong bony fusion between third and fifth lumbar vertebrae.

FIG. 4
Lateral view same date as Fig. 3.

time, in consultation with an internist and a general surgeon, both very able men, the following findings were reported: "Back tender over lower portion, especially about the right iliac crest. Slight muscular rigidity. Right quadrant tender on bimanual examination. No masses found." Roentgenograms of the spine (Fig. 1), kidneys, ureters, and bladder at this time were reported normal.

Ten days after onset, an operation was performed by an able general surgeon for perinephritic abscess. The right kidney region was found to be normal. A small abscess was found deep under the psoas muscle. Drainage was established. Cultures of the pus found at this operation showed staphylococcus aureus. The temperature declined, the leucocyte count dropped to 12,200 and the urinalysis became normal.

FIG. 6

Lateral view same date as Fig. 5.

Five weeks later, the lumbar spine presented a slight curvature and the writer was called in consultation. Roentgenograms now revealed (Fig. 2) almost complete destruction of the body of the fourth lumbar vertebra. Osteomyelitis of the spine was easily recognized. Buckling of the spine and possible nerve involvement seemed imminent. The patient was therefore kept supine on a Bradford frame, and his symptoms rapidly subsided.

Eight weeks after onset, a close fitting spica jacket was applied to prevent possible increase of deformity. Four months later, remarkable improvement in the patient's general condition had obtained. Roentgenograms now (Figs. 3 and 4) showed marked callus formation with almost complete regeneration of the destroyed vertebral body.

Eleven months after onset, the patient was allowed up in a well fitting Osgood brace, which carried the greater portion of the weight of the torso on the iliac crests, by axillary crutches. The general condition had steadily improved, and the drainage stopped. Heliotherapy was given, and was continued during the winter in California, while the boy attended college. October, 1927 (twenty-seven months after onset), roentgenograms (Figs. 5 and 6) showed solid bony fusion between the third and fifth lumbar vertebrae, with a little settling of the spine, but almost no deformity. The brace was discarded, and the patient discharged.

On December 11, 1928, he again consulted the writer concerning a small painless mass he had noticed in his right buttock. Roentgenograms on this date revealed no change from those made fourteen months earlier. In the absence of constitutional symptoms and other objective findings, this mass was incised by the patient's physician at the author's suggestion. A small amount of pus and necrotic material was evacuated, —presumably a residual abscess.

TYPHOID OSTEITIS

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In "The Vertebrae" by George and Leonard (Annals of Roentgenology, New York, Paul B. Hoeber, Inc., Vol. VIII, pages 72, 73, 1929), the authors suggest that possibly the generally accepted observation that there is comparatively little bone tissue reaction to the presence of typhoid bacillus may be an "incidental observation which would not hold true generally through a large series of cases".

The bone marrow, like other lymphoid structures, is a favorable location for the typhoid bacillus. The presence of organisms has been repeatedly demonstrated in bone marrow under inoculation experiments and clinically. The bacillus may continue to multiply in bone marrow long after the general infection has subsided. Typhoid organisms have been found viable in corticle abscess cavities long periods after general infection, —even forty-five years. On the other hand, frequent periods of activity in bone abscesses may finally result in spontaneous cure. A typhoid bone abscess shows no tendency to spread as long as there is no secondary infection.

In spite of the uniform infection of the bones during the course of the fever, actual lesions are very rare (about one per cent. of the cases). The lesions are usually solitary. They rarely occur during the course of the fever, but are more in the nature of sequellae than complications. When they do occur there is rarely any fever or constitutional disturbance. The outstanding symptom is pain. There is usually, also, tenderness and swelling. Occasionally redness of the skin is found locally. The lesion is usually in the diaphysis rather than in the metaphysis as in pyogenic osteomyelitis. It is usually very small, rarely larger than a half inch in diameter, and it is usually in the cortex close to, but not exactly under the periosteum. There is very little bone-tissue reaction to the presence of the typhoid bacillus, differentiating the abscess from both Brodie's abscess and syphilitic periostitis.

The microscopic picture is of a stroma infiltrated with masses of polymorphonuclear leucocytes and endothelial leucocytes. The lesion is essentially an endothelial-cell reaction to the presence of typhoid bacilli with secondary invasion of polymorphonuclear leucocytes. The pus has been described as yellow-brown, rust color, and greenish-yellow. While virulent typhoid bacilli do not induce leucocytic reaction, the avirulent type may produce leucocytosis.

Treatment is surgical and consists of complete removal of the diseased tissue. Removal of a corticle abscess in one piece, without exposing the infected surfaces to the surrounding tissue, can probably be followed by primary closure. Secondary closure has been carried out successfully after a few days, both with and without wound disinfection.

CASE REPORT

A. C.—Patient first seen January 5, 1929, because of pain in the right shin. History obtained that she had run a course of typhoid fever the previous May and June. She is a graduate nurse, age twenty-seven years, [illegible] received the routine typhoid and paratyphoid vaccination in 1921, but was infected with typhoid on April 30, 1928. Two weeks later she had severe headache; a month later leucopenia and marked agglutination of bacillus typhosus (1–40). The pain in the leg started during the second month of the course of infection and continued intermittently from that time until operation, seven months later.

At the time of her first appearance, January 5, 1929, she presented visible and palpable thickening and tenderness anteriorly over the right tibia, six inches above the internal malleolus, in an area about two inches in diameter. Anteroposterior radiograph showed no abnormality whatever. Lateral radiograph showed a slight elevation in outline of the anterior cortex, three-quarters of an inch long, with a subjacent abscess cavity one-eighth inch by one-half inch, with no involvement of the medullary outline. Excision of the abscess was advised and accepted a month later. Previous to operation the white count was 12,500, seventy-one per cent. of which were polymorphonuclear cells. Diagnosis was made upon the history of onset of pain in the shin associated with typhoid fever; recurrence of pain and tenderness; and the characteristic radiographic findings of a small corticle bone abscess without tissue reaction.

FIG. 1

Lateral view of tibia showing abscess cavity in anterior cortex.

At operation on February 8, 1929, the anterior cortex was chiseled out, removing the abscess cavity *en bloc*. After removal the cortex was split, exposing the cavity which contained no pus, but a grey, fibrous structure, retracted from the bone wall. The cavity was cultured and produced typical typhoid bacillus in two laboratories. No disinfection of the wound was attempted. The wound was packed with sterile vaseline gauze. There was no postoperative temperature. The wound was first inspected on the eighth day and found clean. Secondary suture was carried out. There was no disturbance as a result of this secondary suture.

Microscopic sections showed the wall of the abscess cavity to be formed by a thin layer of dead bone. The soft tissue within the cavity was a connective-tissue stroma containing endothelial and polymorphonuclear leucocytes.

This case corroborates the generally held opinion that there is very little bone-tissue reaction to the presence of typhoid bacillus; and serves to emphasize the great diagnostic importance of that radiographic finding.

THE ANTINOMY OF TUBERCULOSIS AND INFANTILE PARALYSIS

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The question has been frequently raised in France since 1906 whether a white swelling ever occurs in a limb affected by infantile paralysis. In 1906, when my attention was first called to this subject, I was interne under M. Ménard, of Berck. It was the period when there was discussion of the method of hyperaemia, of Bier, and the rôle that traumatism played in the localization of the tubercle bacillus. It suggested itself to me that a limb affected by the paralysis should be less able to defend itself against an infection and that, in consequence, the tuberculous arthritides should be more frequent in these paralytics, but an inquiry made among the principal orthopaedic French surgeons, particularly among my own teachers, Jalaguier, Kirmisson, Ménard, Villemin, disclosed the unexpected fact, —*i.e.*, none of them had ever encountered a white swelling in a limb affected by infantile paralysis.

I extended my inquiry to the surgical services (Hospices de Bicêtre et de la Salpêtrière), but was unable to find a single case. It seemed to me that some record would have been made in this category, but, as a matter of fact, there was none of any certainty. The observations were old, without radiographs, and it was impossible to make a diagnosis in retrospect. Since this time I have never personally encountered white swelling in a paralyzed limb, and I have many times asked the question of orthopaedic surgeons and have not as yet had a positive response.

In September 1927, at the Congress of French Pediatricians, at Lausanne, I also put the same question to the members of the Congress. No one responded in the affirmative. It is possible that infantile paralysis is not particularly frequently found in our country, yet we have had small epidemics and each one of us has under his care a rather important contingent of paralytics. This is one of the reasons which urged me to approach the surgeons of countries where the epidemics are severe and extended.

It can be questioned whether there exists an actual antinomy between infantile paralysis and tuberculous osteo-arthritis. Does the infantile paralysis, in a way, vaccinate against tuberculosis? Is it a question only of local immunity? It is easy to suggest the explanation that as paralyzed limbs work but little they are less subject to fatigue, to traumatism, etc. In other words, they present less the conditions which appear to favor the development of tuberculosis. This is true certainly in a member that is entirely involved by paralysis,—inert, having lost its usefulness. But, on

the contrary, a lower limb partly paralyzed develops a very considerable degree of activity and is subjected to physiological traumatisms like those to which a well member is subjected,—more, by reason of its handicap, it is obliged to perform a supplementary degree of work in order to preserve the equilibrium of the whole body, and it cannot easily avoid the traumatism of direct shocks and slight strains frequently repeated.

Moreover, the explanation entirely fails if we consider the vertebral column. Paralytic scoliosis is frequently extreme in degree and these spines are very evidently the seat of violent traumata. Therefore, in this connection it may be asked whether Pott's disease ever supervenes on a paralytic scoliosis.

It might seem, therefore, that the segments of the body involved by a paralysis are immune to tuberculous osteo-arthritis. Perhaps it can be stated that such subjects generally do not find themselves in a favorable condition to develop tuberculosis, but this is less probable for the following reason,—it is not uncommon to observe in the relatives certain cases of tuberculosis. We frequently find in the observations of a case of infantile paralysis that a father or mother or brother is tuberculous, the diagnosis having been confirmed by a laboratory examination. Therefore, the infantile patient is in a contaminated medium.

Another question, then, to consider is whether a patient affected with a localized paralysis is able to develop an osteo-articular tuberculosis in one of the healthy limbs. Four or five years ago I believed this possible. I saw at that time a young child, three and one-half years old, with an arthritis of the right wrist. It was evidently a question of a bacillus arthritis, swelling of the lower third of the forearm, with a resistance of the anterior portion. Pronation was limited; supination normal. Flexion, extension, adduction, and abduction of the wrist were limited but only slightly painful. There was a small epitrochlear ganglion. The radiograph showed a cavity in the inferior extremity of the radial diaphysis, with a marked decalcification, a periosteal thickening, and nearly total disappearance of the epiphyseal area. This lesion, which could be called a spina ventosa of the lower end of the radius, is not pathognomonic either of tuberculosis or syphilis. Moreover, there was found a spina ventosa of the first phalanx of the fifth finger of the right hand, cicatrized, the nature of which I could not determine. Therefore, here was a case of infantile paralysis of sixteen months' duration of the two lower limbs and no involvement of the upper, with a sequela of nearly complete paralysis of the quadriceps and of the anterior portion of the right leg. In spite of a positive skin reaction and of a negative Bordet-Wassermann, by reason of the sluggishness of the lesion, I added to the treatment of immobilization a treatment of *sulfarsénobenzol*, with a complete cure of the wrist in a few months. The proof is not complete that it was actually a tuberculosis.

On the other hand, is it possible that children and adults attacked by infantile paralysis can develop a visceral tuberculosis, and particularly a pulmonary tuberculosis? Instances appear to be very rare. Certain cases

of ordinary scoliosis, severe, develop a pulmonary tuberculosis, but the paralytic scoliotics die of some other complication and we do not see those affected with paralyses of the limbs die with tuberculosis. We cannot draw, moreover, from this fact a premature conclusion, but we may repeat that it may be questioned if there cannot be a certain antinomy between tuberculosis and infantile paralysis.

In order to clarify this question, which to me appears important in its consequences, in 1907 I began certain experimental research and I resumed it in 1910 in collaboration with my friend, Henri Bénard, physician in the Hôpitaux de Paris. However, in spite of very numerous observations undertaken both with the rabbit and with the dog, we have arrived at no positive conclusion.

The following plan was elaborated in order to make a comparative experimentation, in the attempt to reproduce all of the paralyses, the defects of injection, and hyperaemias.

For this we have attempted to produce in the brain and the spinal cord, local destruction by a partial ablation, and compression by paraffin injection or sclerosis by alcoholic injections Moreover, in different levels of the spinal cord we have cut a greater or less number of the nerve roots and have obtained certain localized paralyses, but this is not always easy. It is not possible, for instance, to appreciate, before having seen it, the tolerance of the brain of the rabbit to paraffin. After an important injection there has occurred a complete paralysis of one paw or of one-half of the body, but no trace of this remained fifteen days afterward.

Moreover, we have tried to obtain various paralytic manifestations in the limbs by changing the technique, such as, for instance, the ligature of the principal artery of the limb; the ligature of the accompanying vein; the simultaneous ligature of both vessels; resection of the principal nerve or one of its largest branches; resection of the associated nerve or ligature of the two principal vessels.

When the experiment has succeeded in producing a partial paralysis, we have then tried to produce a local tuberculosis, but unfortunately it is very difficult to obtain these localized paralyses, although this may appear somewhat paradoxical. They are either too slight and fleeting or, on the contrary, too generalized or too severe, and do not allow opportunity for experimentation. This does not apply, however, to a case in which there supervened an extensive gangrene.

We have then injected different cultures of tubercle bacilli, either intravenously or locally in the knee or the elbow, intra-articular injections into a cavity, or intra-osseous in the epiphysis of one of the bones. In the case of local injections the same procedure has been used in the well limb, in order to have a control for comparison.

The destruction is enormous. It produces very often septic complications because of the trophic disturbances, and the animals are useless. We have tried to sacrifice these early, but in these cases there has never been a sufficiently notable difference between the paralyzed member and the

control member. In the dogs it has seemed that in the local injections (intra-articular or intra-osseous) the articular reaction was much less accentuated on the paralyzed side. But these experiments are difficult to follow, for the animals become ill and easily develop complications to which they succumb, generally before the local lesions have had time to sufficiently develop for comparison.

We have never seen a localization in the paralyzed member as a result of the intravenous injections, but due to some extrinsic causes these experiments have not been carried far enough to justify any conclusion.

These experiments should be, without doubt, extended to the monkey, in order that one might obtain with it the lasting paralyses by inoculation of the virus of poliomyelitis and at the same time observe the presence of antibodies in its blood.

While waiting for these results, it seemed to us interesting to pursue the research in the direction of direct experimentation. I asked the members of the Congress of Pediatricians if, in cases of white swelling, they would inject the serum taken from the paralytic subject. Because of the number of cases of paralysis, it is now quite possible to obtain this serum from these subjects.

On the one hand, the French works (Prof. Etienne, Prof. A. Netter) have shown the clinical efficiency of serum prepared by Prof. Auguste Pettit of the Pasteur Institute. The serum from a horse is only obtainable in very small quantities, but without doubt it is possible to further experiment with it. On the other hand, in America, Neustadter, Bamzaf and Théo, Nuzum and Willy, Rosenow and Nickel have experimented in subjects of poliomyelitis with serums more or less different from those of Pettit and which they produce in relatively large quantities. It should be possible, therefore, to succeed with these materials.

CONCLUSIONS

The white swellings in the limbs afflicted by infantile paralysis would appear to be excessively rare. Personally, I have never encountered one. It would be interesting to have indisputable observations, confirmed by laboratory examinations, of the white swelling which develops either in the well limbs of the subject of infantile paralysis or in a paralyzed limb of the same.

In case it is confirmed that there exists a certain antinomy between infantile paralysis and tuberculosis, it would be necessary to extend the experimental studies to the monkey inoculated successively by virus of poliomyelitis and by tubercle bacillus.

It would seem useful to determine in the first place if it is a question of a local immunity or of general immunity, and therefore one could also carry the experimentation to man, using both the serum obtained from a subject of paralysis and serum obtained from the animal.

CONGENITAL DISLOCATION OF HIP

An Anatomical Study of a Case of Bilateral Congenital Dislocation of the Hip and Other Associated Congenital Deformities in a Male Infant Eleven Days Old

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Diagnosis of congenitally dislocated hips in the new-born or in the foetus is very uncommon, and opportunities for the anatomical study are quite rare. Because of the great scarcity of anatomical material secured during foetal or early infant life, an additional case is reported somewhat in detail.

Diagnosis of bilateral congenital dislocation of the hip on the second day of life is a unique experience, and especially so when the dislocation is accompanied by other deformities which point to a common etiological factor. Death occurring on the eleventh day of life made anatomical study possible.

The details of the examination and anatomical findings of the case constituting this study should be preceded by a brief review of the antepartum history as obtained from the mother and the obstetrician in attendance.

The mother was a German girl of nineteen years, born in the United States. There was no history of previous illness or prenatal trauma, familial diseases or congenital deformities. The maternal blood Wassermann was negative. She was employed as a factory worker and continued at this occupation until three weeks from term. The last preceding menstrual period was in March 1926; "quickening" occurred during October. Both dates coincided with a history of full-term pregnancy in January. Throughout the later weeks of gestation, the foetus and uterus were of small size, easily concealed, and not interfering with the mother's employment. About one week previ-

FIG. 1

FIG. 2

Figs. 1 and 2. Left lateral and anterior views of specimen after fixation in formalin, showing multiple deformities due to compression of foetal ovoid. Note hyperextension of knees over forearms.

ous to delivery, all foetal movements stopped abruptly. Labor set in, and the patient entered St. Luke's Hospital, Chicago, on the Obstetrical Service of Dr. C. E. Paddock. The membranes ruptured spontaneously and only about four or five ounces of amniotic fluid were released. Labor continued over a period of thirty-six hours and was severe during the latter part. No explanation could be made for this on repeated pelvic examination. Birth occurred January 20, 1927, and was precipitate in its rapidity. The position was that of a vertex in the R. O. A. Antepartum pelvimetry showed the pelvis to be of large size, and normal in shape, the measurements being:

Interspinous	25	centimeters
Intercrestal	28.5	centimeters
Intertrochanteric	34	centimeters
Ext. Conjugate	22	centimeters
Outlet	11	centimeters
Diag. Conjugate	12+	centimeters
Outlet	12	centimeters

Roentgenograms of the pelvis revealed no abnormality. The placenta was semicircular in shape, the cord being attached about the middle of the straight margin.

The convalescence of the mother was uneventful.

The infant was a male weighing 2880 grams, of good nutrition and condition, with the exception of a moderate general cyanosis.

Immediately after birth it was noted that both arms assumed a flexed position, the forearms resting across the lower thorax with the hands completely extended at the wrist, but with the fingers completely flexed. Bilateral "back-knee" and bilateral calcaneus club-foot were noted, as were false points of motion in both mid-thigh regions.

The writer saw this infant one day after birth and found the following conditions:

The infant (Figs. 1 and 2) was a male, well nourished and in fairly good general condition, excepting for a generalized cyanosis of moderate degree. The head was held quite acutely flexed with the chin rotated to the left. The dorsal back was very prominent and a right dorsal kyphoscoliosis was very evident.

Both arms were in a position of ninety degrees flexion at the elbows and rested most easily across the upper abdomen with the hands meeting in the midline. Both hands were extended to the forearm at the wrists and the fingers were completely flexed. The integument over the dorsum of the wrist lay in deep, sharply defined folds, suggesting firm compression into the position of deformity. The soft tissues of the fingers were angular, the skin creases deep and apparently due to passively forced flexion and compression. Active motion was present at the shoulders and elbows and during the subsequent days the deformities of the wrists and fingers became less persistent.

Both feet showed identical deformities of extreme calcaneus position. The toes were flexed and all deviated laterally. Deep flexion creases were present across the dorsum of the ankle, and the toes presented the angular compressed appearance seen in the fingers of both hands.

Both knees were in the position of hyperextension of about sixty degrees. The condyles of both femora were distinctly palpable in the popliteal spaces. Across the anterior aspect of each knee the integument lay in deep, sharply defined, transverse creases. Both patellae could be palpated lying against the anterior aspect of the femora. Both thighs were angulated anteriorly at about the middle thirds. False points of motion and bony crepitus were present, indicating recent fractures of the shafts of both femora. No callus or thickening of the soft parts was present. The hips persisted in a position of flexion and the fragments of the femora were brought into line only by flexion of the legs over the abdomen and chest. Deep skin creases were present over the anterior of each hip. Both greater trochanters were high and in posterior positions.

Roentgenograms confirmed the above findings of the deformities of the spine, wrists, feet, and knees. Short oblique fractures of almost identical types were present in the middle thirds of the femoral shafts. The femoral heads were dislocated from the acetabula, being in positions posterior and superior.

In summary the following diagnoses were made and confirmed by roentgenograms:

1. Right kyphoscoliosis of the dorsal spine.
2. Bilateral congenital club-hand.
3. Bilateral congenital dislocation of the hip.
4. Bilateral fracture of the middle third of the femur.
5. Bilateral congenital genu recurvatum.
6. Bilateral congenital calcaneus club-foot.

Because of the infant's poor condition, he was transferred to the Pediatric Service of Dr. Isaac A. Abt. On February 1, 1927, a temperature of 104 degrees developed and on that day death occurred, the infant being eleven days old.

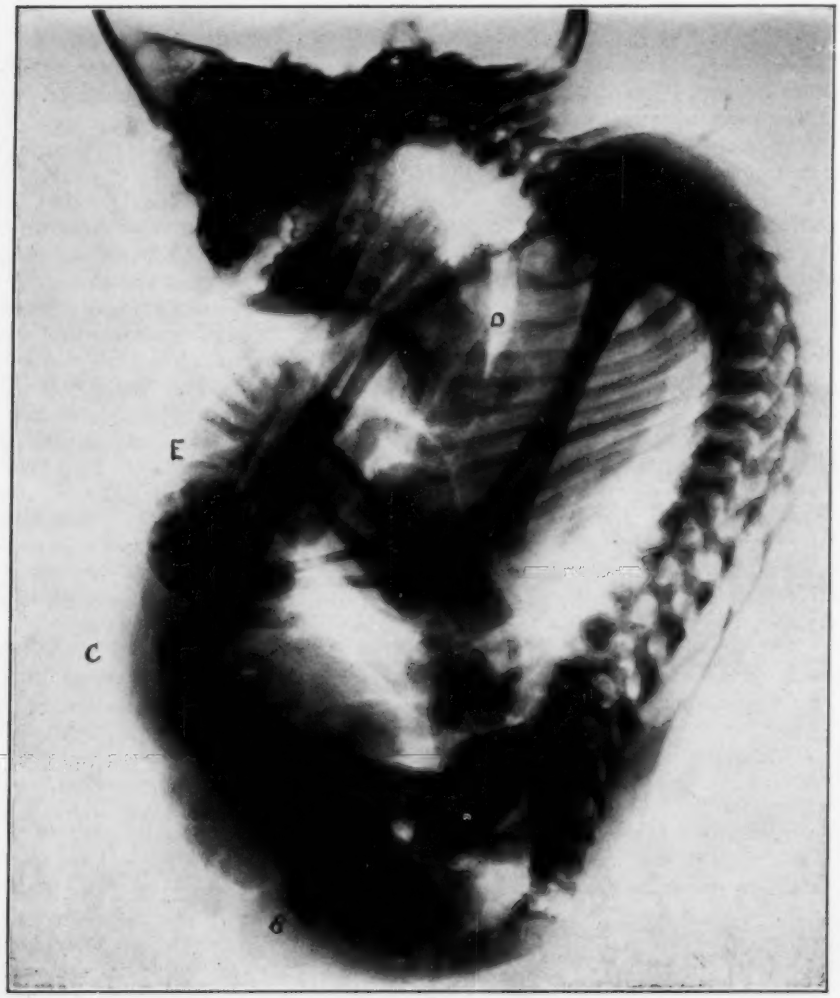

FIG. 3

Lateral roentgenogram of Fig. 1, after fixation in formalin. *A*. Dislocation of hips. *B*. Fracture of femur. *C*. Hyperextension of knees. *D*. Calcaneus deformities of feet. *E*. Club hands, and dorsal kyphoscoliosis of spine.

FIG. 4

Roentgenogram of left upper and lower extremities showing dislocations and deformities. Before fixation in formalin.

FIG. 5

Anteroposterior roentgenogram of torso and pelvis, before fixation—after dissection of right hip. Note callus about distal end of proximal fragment of right femur.

The orthopaedic treatment during this infant's life consisted of frequent manipulations of the deformities of the hands and feet and immobilization of the fractured femora.

A general autopsy was performed by Dr. S. W. Crowe of the Pathological Department of St. Luke's Hospital. The histological findings are summarized as follows:

"Congenital atelectasis of the lung; oedema, hyperaemia and hemorrhage of the lung. Oedema of the testes. Moderate hyperaemia of the spleen. Slight fatty changes of the liver. Hyperaemia of the kidney. Slight oedema of the myocardium. Oedema of the pancreas. Specially stained sections of pancreas, lung, liver and heart showed no spirilla."

It is well to note that a large smooth callus was palpable in the center of each thigh, during the last few days of life. (See Figure 11.)

Both hips showed identical deformities and anatomical changes. The articulation of the right hip will be described. The periarticular structures of the left hip were dissected and are described below. Each description applies to the same structures of the opposite joint.

Right hip.—An attempt was made to reduce the dislocation of the right hip very shortly after death. Direct pressure over the dislocated greater trochanter was not effectual and traction and manipulation could not be used efficiently because of the soft, yielding callus at the site of fracture of the right femur.

The muscles about the right hip were dissected and reflected from about the capsule and the head of the femur. The femoral head was found dislocated, being in a position just proximal and posterior to the posterior superior margin of the acetabulum. It was covered by a thin fibrous capsule which extended to its normal attachment about

FIG. 6

Dissection showing right hip dislocation. Note the well formed acetabulum, intact ligamentum teres and fossa formed by superior capsule and gluteus minimus muscle. *1.* Crest of ilium. *2.* Anterior superior spine. *3.* Acetabulum. *4.* Tuberosity of ischium. *5.* Femoral head.

the acetabular margins. The capsule was intact throughout and showed moderate constriction and flattening as it bridged across the empty acetabulum. The iliofemoral ligament was found as a thin flat band of tissue forming the anterior portion of the capsule. This had apparently yielded as the rest of the capsular structures on dislocation.

The joint was opened in its antero-inferior aspect and the femur abducted (Figs. 6 and 7). The following measurements of the femoral head and acetabulum were made:

Right Femoral Head		*Right Acetabulum*	
Vertical diameter (outside)	1.22 centimeters	(inside)	.96 centimeters
Horizontal diameter "	1.30 centimeters	"	1.04 centimeters
Oblique diameter "	1.16 centimeters	"	.97 centimeters
Oblique diameter "	1.19 centimeters	"	.85 centimeters
Approximate thickness	.85 centimeters		
Approximate depth	.7 centimeters		

Right Ligamentum Teres		*Anatomical Neck of Femur*	
Length	1.78 centimeters	Transverse diameter	1.2 centimeters
Width	.4 to .28 centimeters	Vertical diameter	1.3 centimeters
Thickness	.1 centimeters	Long axis over all	2.47 centimeters
Cotyloid notch at free margin	.44 centimeters		

The head of the right femur was found resting in a smooth synovia-lined fossa formed by the superior portion of the capsule, above and posterior to the margin of the acetabulum. The head was somewhat triangular in shape with the base on the superior aspect. This shape conformed closely to the angle formed by the upper margin of the acetabulum and the lateral aspect of the ilium. The head was found to fit well into this region when dislocated posteriorly and superiorly with the thigh in marked flexion.

The ligamentum teres was elongated and ribbonlike, resting across the posterior superior margin of the acetabular rim. Depressions were present in the cartilage of the femoral head and acetabular margin at points of contact with the interposed ligamentum teres. There was no evidence of rupture of the tendon fibers.

The long axis of the head and neck made an angle of 125 degrees with the shaft of the femur. No anteversion was present. In its stead was about twenty degrees of retroflexion occurring in the femoral neck. This was apparently due to yielding of the head and neck to the exaggerated pull of the external rotators and the resistance to external rotation offered by the capsule and the gluteus minimus muscles.

The margins of the cartilaginous acetabulum were well developed except for a rounded overhanging of cartilage which distinctly decreased the diameters of the cotyloid cavity. This cavity was moderately triangular in shape, the three sides corresponding to the epiphyses forming the joint. The acetabular fossa showed no more than a suggestion of the epiphyseal eminences so frequently seen in older unreduced hips. Considerable fibrous tissue surrounded the origin of the ligamentum teres. There was, however, no evidence of an exudate in the acetabulum or synovial sac which would suggest recent trauma.

On attempted reposition of the femoral head into the acetabulum, it could be made to engage to only about twenty per cent. of its surface, the reduplicated ligamentum teres and the overhanging acetabular margins obstructing.

The fracture of the right femur is shown in Figures 3, 4, and 5 and the callus which has reached a diameter of from one and seventy-five one-hundredths centimeters to two centimeters is shown in Figure 11.

A dissection of the right knee revealed a typical genu recurvatum with marked stretching of the structures of the posterior aspect of the joint. Although the roentgenograms of the knee showed practically no patellar shadow (Figs. 3 and 4), longitudinal section of the knee joint revealed a well developed cartilaginous patella (Figs. 8, 9, and 10), differing in this respect from the findings of recent writers on this subject.

The left hip was found flexed to about eighty degrees, and externally rotated seventy-five degrees. The greater trochanter and femoral head were palpable in a position posterior and superior to the acetabulum. The dissection was done after the body was fixed in formalin.

The gluteus maximus muscle extended from the sacrum and posterior portion of the iliac crest, as a broad, thin, fibrous band passing directly over the greater trochanter to its insertion in the gluteal tuberosity. This muscle formed a sling which would act as a fulcrum, further dislocating the femoral head on external rotation of the femur in the flexed position (Fig. 12).

The gluteus medius was next exposed. It was a broad, well developed muscle which extended from its origin on the ilium to its insertion on the anterosuperior aspect of the greater trochanter. The muscle fibers were nearly parallel and formed a right angle with the long axis of the femoral shaft.

Posteriorly, and separated from the gluteus medius muscle by three millimeters, was the piriformis muscle. This was cylindrical in shape, two millimeters in diameter,

FIG. 7

Dissection showing right hip dislocation. Note the well formed acetabulum, intact ligamentum teres and fossa formed by superior capsule and gluteus minimus muscle. *1*. Crest of ilium. *2*. Anterior superior spine. *3*. Acetabulum. *4*. Tuberosity of ischium. *5*. Femoral head.

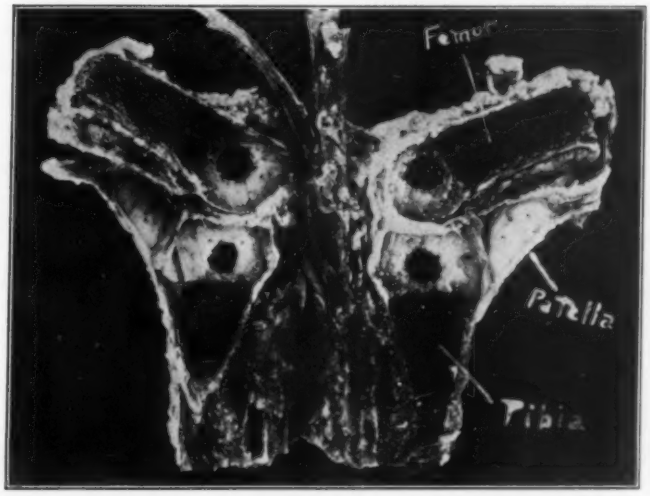

FIG. 8

Longitudinal section of right knee joint. Note patella in concavity between femur and tibia.

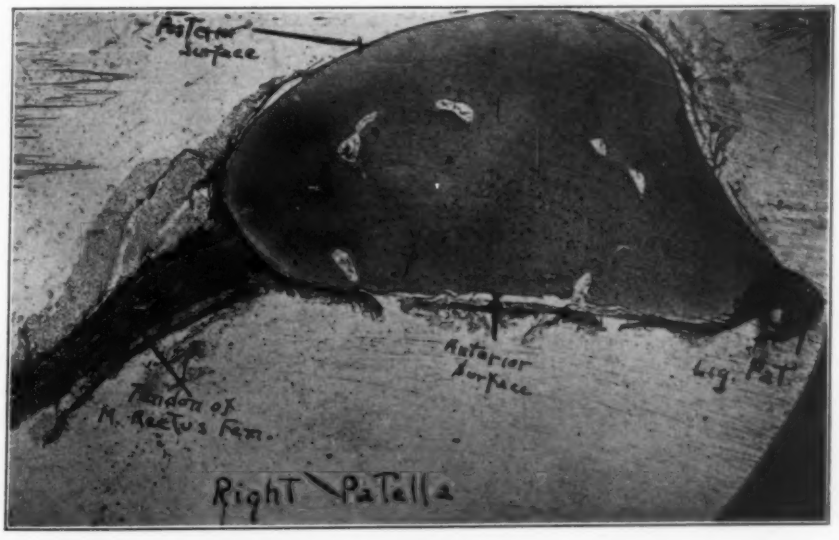

FIG. 9

Photomicrograph of longitudinal section of right patella. No evidence of ossification of cartilage present. (× 8.)

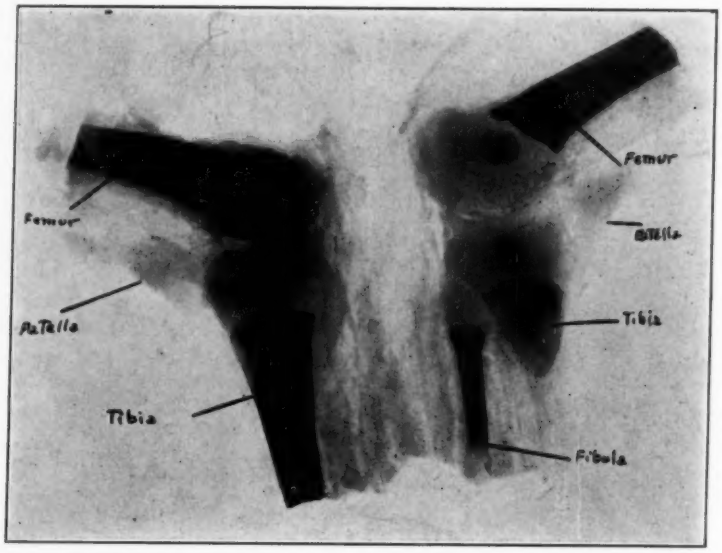

FIG. 10
Roentgenogram of right knee (Fig. 8).

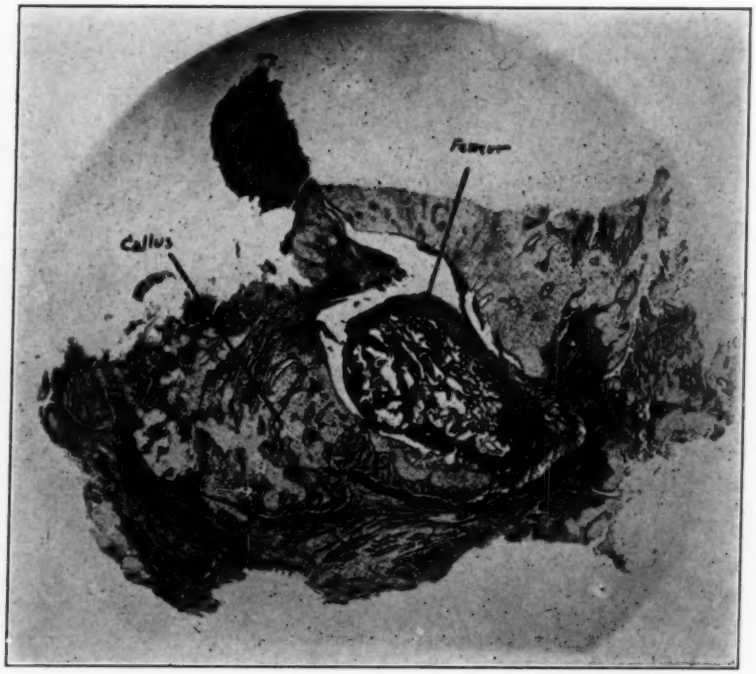

FIG. 11
Photomicrograph of section of fracture of right femur.

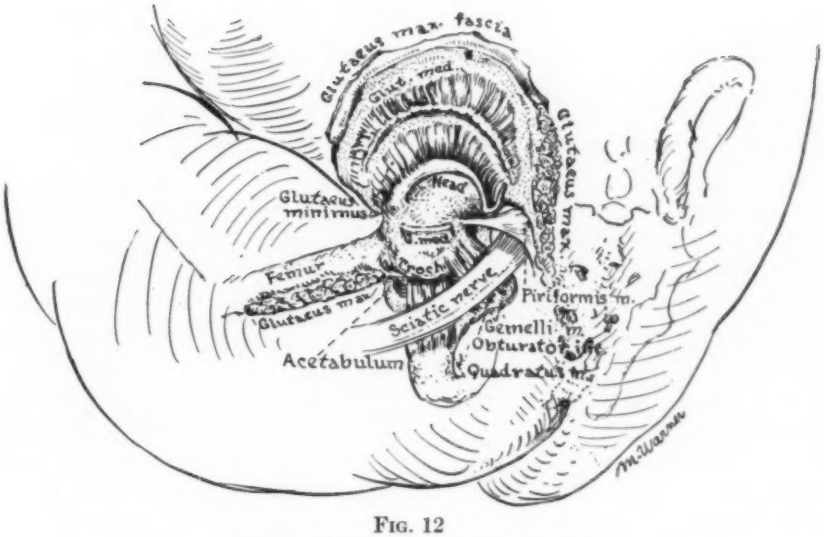

FIG. 12
Drawing showing muscles of left hip.

and one and five-tenths centimeters in length. It lay in the transverse coronal plane and was well separated from the sciatic nerve.

The sciatic nerve was of normal appearance except for some flattening, being eight millimeters in width and two millimeters thick. It lay in relation to and crossed the gemelli, the obturator internus, and the quadratus femoris muscles. These latter muscles passed from their origins laterally and cephalad to insert into the posterior aspect of the greater trochanter. This position enhanced their function of external rotation, and with the femoral head disengaged, would facilitate further dislocation.

The gluteus minimus muscle, with the joint capsule, formed a pocket in which lay the dislocated head, preventing further posterior as well as superior displacement. The joint capsule was very thin and intact throughout. It fitted snugly over the dislocated head, between it and the gluteus minimus muscle.

The iliopsoas and the reflected head of the rectus femoris muscle compressed the anterior and inferior portions of the elongated capsule.

A dissection was made of the dorsal and lumbar portions of the spinal cord and its terminal roots, but none other than normal structures were found.

The intra-uterine life of this male infant suggests somewhat more than the usual constriction and compression. The small amount of amniotic fluid and the altered placental migration may be considered as evidence of a somewhat distorted physiology and an increase of pressure upon the foetus. Dystocia during labor followed by a precipitant delivery was due to the increased trunk diameters which included the fully flexed hips and over-extended knees. This position, as in a frank breech, caused wedging, relieved only when the uterine contractions were sufficiently strong to fracture both femora, permitting rapid progress through the pelvic outlet.

Inasmuch as both hips revealed no evidence of sudden trauma by the presence of blood or capsular or ligamentous rupture, even in the presence of force sufficient to fracture the femoral shafts, it may be concluded that

dislocation occurred previous to birth. The dislocating forces acted over a period of sufficiently long duration to permit adaptive elongation of the capsule and ligamentum teres. The preexistence of the dislocation may also be supported by the superior posterior position rather than the inferior displacement which would most likely result from such trauma during birth.

The associated deformities of the spine, hands, knees, and feet are evidence of compression of the foetal ovoid during the later part of foetal life. The presence of loose, deeply wrinkled, and creased integument at the wrists, ankles, knees, and hips also bears evidence of passive deformities occurring after the skin had adapted itself to the normal contours of the involved parts.

The reconstruction of the theoretical course of events resulting in these many associated deformities is as follows: The foetus was of normal heritage and developed normally under average conditions *in utero*, moving freely about in its cushion of amniotic fluid. The extremities were normally covered with integument. For some unknown reason the amount of amniotic fluid became less in amount, and the foetus was caught in the ovoid position (Figs. 1 and 2). The disproportion between the cramped foetal ovoid and the uterine cavity became more marked by the growth of the foetus. As a result of the increased compression, the head and cervical spine assumed positions of left anterolateral flexion. The lower extremities were hyperextended over the semiflexed arms. The hips were dislocated by direct pressure upon the greater trochanters, aided by external rotation of the hyperextended legs. Birth was possible only by fracture of the acutely flexed femora.

The findings in this case do not explain the greater frequency of dislocation among females or the suggested hereditary predisposition. They do, however, point to direct pressure upon the foetus by the uterine muscle as the etiological factor in this instance.

TUBERCULOUS OSTEITIS WITH PATHOLOGIC RESECTION OF SEVENTH RIB*

BY A. M. RECHTMAN, M.D., PHILADELPHIA, PA.

CASE REPORT

History: J. R., a female, twenty-three months old, was well until seven months previous to this examination. The left knee became swollen and at times was red. The child had not walked for six months. Two months after the onset of the disease in the knee, the parents noticed a mass on the left chest which did not increase in size and at first was not painful.

Examination: A bilocular, smooth, apparently cystic growth, one and three-quarters inches long and three-quarters of an inch in width, was palpated on the left anterolateral aspect of the chest, extending downward from the seventh rib. The overlying skin was unattached, but the mass was attached to the underlying tissues. The loculi of the cyst communicated and pressure on the larger one above forced its contents into the other and vice versa. The growth and surrounding tissues were not inflamed nor painful to pressure.

The left knee was fixed by muscle spasm and pain in 110 degrees of extension. The local temperature was increased, the tissues thickened, and the lateral sulci of the knee obliterated by swelling. The tibia was slightly subluxated backward on the femur. There was a fluctuating, sausage-like swelling on the anterolateral aspect in the lower third of the thigh just above the patella.

The patient's general condition, according to the referring physician, showed considerable improvement in the last six months. Examination of the heart and lungs was negative. The blood Wassermann was negative.

January 27, 1925: Forty cubic centimeters of a creamy, flocculent, typically tuberculous pus were aspirated from the sausage-like mass and a long plaster spica was applied.

Examination on February 18, 1925: The child awakened three or four times with night cries during the past two nights and was slightly irritable. The knee extended to 150 degrees and the fluid had not reaccumulated. The cyst on the chest wall was unilocular and seemed slightly larger.

March 9, 1925: Thirty cubic centimeters of tuberculous debris were aspirated from the quadriceps bursa, more watery than that previously removed and containing considerable caseous material. The patient slept well, but frequently broke her plaster spicas because of wetting, and a steel brace was therefore made.

May 20, 1925: The patient's general condition showed marked improvement. The tissues about the left knee were thickened. The cyst on the chest wall was unilocular and slightly larger. Her temperature was ninety-nine degrees.

June 1, 1925: A pin-point sinus formed on the lateral aspect of the thigh above the knee.

June 2, 1925: X-ray examination showed a tuberculous infectious arthritis of the lower end of the femur. The patella seemed to be involved. There was periarticular swelling and extravasation of fluid into the joint which was subluxated.

June 8, 1925: The cystic mass on the chest was aspirated and material similar to that removed from the knee was obtained.

*Case presented before the Philadelphia Orthopaedic Club.

X-ray made June 9, 1925, showed a cystic swelling which might have originated from the seventh rib anteriorly, as there seemed to be a little bone atrophy. It was purely a soft-tissue and not a bone tumor.

Examination on June 11, 1925, showed the area of redness over the cyst had increased and rupture seemed inevitable.

Operation on June 12, 1925: A transverse incision, one and one-half inches long, was made below the tumor mass on the left lateral aspect of the chest. The abscess sac was dissected, inadvertently opened, and removed *en masse*. The base extended to the seventh rib in the mid-axillary line where a pathologic resection of the rib had occurred. All the debris was removed, leaving a three-quarters inch gap in the course of the rib. The wound was closed in two layers without drainage. The histologic examination showed tuberculosis.

December 19, 1925: The wound healed in one month, and was still healed when the patient was last seen.

Examination of the knee showed that the sinus had healed. There was a fifteen-degree flexion deformity and ten degrees of painless motion. There was marked atrophy, but no shortening.

The condition was undoubtedly a synovial tuberculosis with later involvement of the bones of the knee joint and metastasis or secondary involvement of the rib. The writer has seen no other such case in his hospital or office practice.

Tuberculous osteitis of the chest wall is an uncommon condition and many books on orthopaedic surgery, old and new, do not mention it. Freeman[1] states that a purulent foci surrounding a tuberculous rib must be differentiated by the history from a typhoid abscess, which it closely resembles. Excision of the diseased section of the rib is usually required. Albee[2] says the condition may be primary or secondary and advises operation. Dupuytren[3] reports a case of tuberculous osteitis of the ribs by extension from an adjacent dorsal vertebral suppuration in a patient twenty-three years of age. This man had tuberculosis of the lungs previous to the bone involvement.

Viannay[4] reports two cases of tuberculous osteitis of the thoracic wall with extensive operation. In the first case, that of a man of sixty-five, healing occurred in three weeks; and in the second case, that of a woman of twenty, the wound healed in four weeks.

Lenormant[5] also reports two cases of tuberculous osteitis of the ribs with spontaneous fracture. The first, a woman aged sixty-five, showed no other evidence of tuberculous disease. The process was in the ninth rib, axillary region. After operation, the wound healed by primary intention despite the presence of a cold abscess for which the patient came to the hospital. The second patient, a man sixty-five years of age, came to the hospital because of pain in the entire left chest which had been present for six weeks. While coughing he suddenly felt a crackling below the left nipple. Upon operation a sac containing pus was excised and a portion of the rib resected. The wound healed by primary union.

Of the last four cases all but the third patient had a pneumo-thorax as a result of the operation, but experienced no difficulties in their convalescence.

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A CASE OF CONGENITAL ASYMMETRICAL SHORTENING OF METACARPALS ASSOCIATED WITH A MARKED BILATERAL METATARSUS ATAVICUS

BY S. S. HANFLIG, M.D., NEW YORK

From Department of Surgery, Yale Medical School, New Haven, Conn.

The following case report is presented as an unusual one. Metatarsus atavicus, as an atavistic reversion, has been described by Dr. Morton. Shortening of the metacarpals, however, is not an atavistic reversion. On the contrary, the tendency in the development of the human hand with its grasping ability has been from a long metacarpal to a shorter. Without endeavoring to explain the anomalies herein presented, the following case is reported.

W. M., forty-two, married, American-born, machinist, presented himself with a chief complaint of pain in his left anterior chest wall at the cartilage of the sixth and seventh ribs. His complaint dated back to an injury received one year before his admission. Physical examination showed an irregularity at the junction of the sixth and seventh costal cartilages on the left. There was also some crepitus on moving this irregularity. This was interpreted to be an old unhealed cartilaginous injury.

At the examination it was noticed that his hands were unusual. Figures 1 and 2 demonstrate the peculiarities noted. The right hand had unusually short first and third metacarpals. The end of the right thumb had been traumatically amputated many years before. The situation of the right third metacarpophalangeal joint was unusual. The disproportion between the length of the fingers was striking (See Figure 1). The left hand showed a similar shortening of the fifth metacarpal (See Figures 1 and 2). X-rays of the hands revealed these anomalies very strikingly (See Figures 3 and 4).

The patient stated that his hands had been so since birth. They had never interfered with his work as a machinist. No one else in the family had ever had a similar condition.

X-rays of all the bones of the body revealed additional anomalies. There was

FIG. 1

FIG. 2

FIG. 3. Right hand.

FIG. 4. Left hand.

FIG. 5. Left foot.

FIG. 6. Right foot.

bilateral metatarsus atavicus with an unusually short left first metatarsus (See Figures 5 and 6). Patient had never had any pain or discomfort in his feet.

The x-rays of the hands and feet demonstrate the anomalies described. Interesting to note are the compensatory thickening of the shortened bones and the compensatory lengthening of the bones distal to the shortened ones.

SPLINTERING SUBPERIOSTEAL OSTEOTOMY FOR MALUNITED FRACTURE OF THE FEMUR*

BY HENRY MILCH, M.D., F.A.C.S., NEW YORK, N. Y.

The correction of a single curvature of the long bone is usually easily accomplished by the performance of either simple or cuneiform osteotomy. Even in the case of double curvature, these procedures may result satisfactorily. However, when the curvature in two planes takes place over a somewhat extended area, the correction by a single operation is more difficult. In the case quoted below, correction of the two curves was attempted by a procedure originally described by Kirschner[1] but here reported for the first time in this country.

J. C., age thirty-two, was admitted to the Service of Dr. Finkelstein at the Hospital for Joint Diseases on January 21, 1927, with the history of having been struck by an automobile eight months before and of having suffered a fracture of the lower third of the right femur. He was immediately taken to a hospital in New Jersey where a closed reduction was undertaken, and a spica plaster-of-Paris cast extending to the toes was applied. This was left on for six weeks. Upon removal of the cast, it was found that the patient had a marked anterior bowing of the femur with a moderate degree of external angulation. To overcome this an ice-tongs was applied and traction was continued for four weeks. At the end of that time the patient was discharged. On admission to our hospital there was present practically the same deformity (See Figure 1). The patient complained of no pain, but observed that on walking he felt a tenseness in the lower part of the thigh and about the knee. Two small scars on either side of the thigh indicated where the ice-tongs had been applied. The lower part of the thigh showed an anterior bowing of about forty degrees and an external angulation of about twenty-five degrees. There was about an inch of shortening in the right extremity. The x-ray showed an old healed malunited fracture of the lower third of the femur with angulations corresponding to those seen on physical examination.

On January 27, under a tourniquet, a six-inch external lateral incision over the area of the curvature was made. The femur was exposed and the periosteum dissected away from the bone over a distance of about six inches. A heavy bone elevator was slipped beneath the bone, and with a broad chisel and a mallet the bone was splintered in a longitudinal manner so that flexibility was restored. The periosteum was thereupon sutured, the muscles approximated, and the skin closed. After the dressing was on, the deformity was corrected and a plaster spica applied to below the knee.

X-rays taken subsequently showed that the angulation had been overcome, but that there was a slight transposition of the lower fragment. To overcome this, at the end of two weeks, mole-skin adhesive straps were applied, and traction (15 pounds) applied for the purpose of overcoming shortening and of securing normal alignment of the parts. Though the transposition was not completely overcome, leaving the axes of both fragments parallel but not continuous, the longitudinal axis of weight-bearing was completely restored, as may be seen in Figure 2.

Unfortunately, as the result of infection during dressing, a low grade osteomyelitis developed and several very small sequestra were extruded.

*Submitted for publication, May 3, 1929.

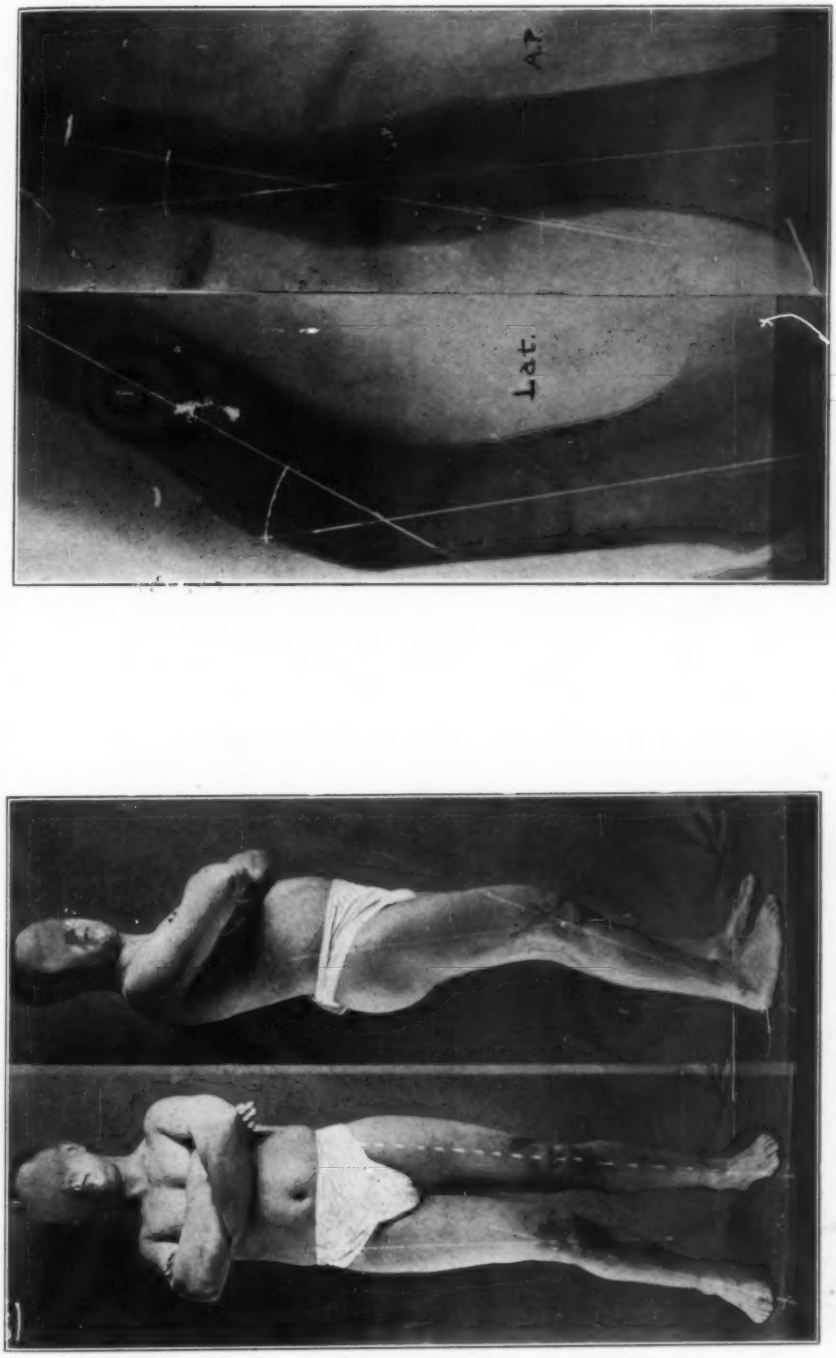

FIG. 1

Anteroposterior and lateral photograph and x-ray taken before operation, showing angulation in two planes.

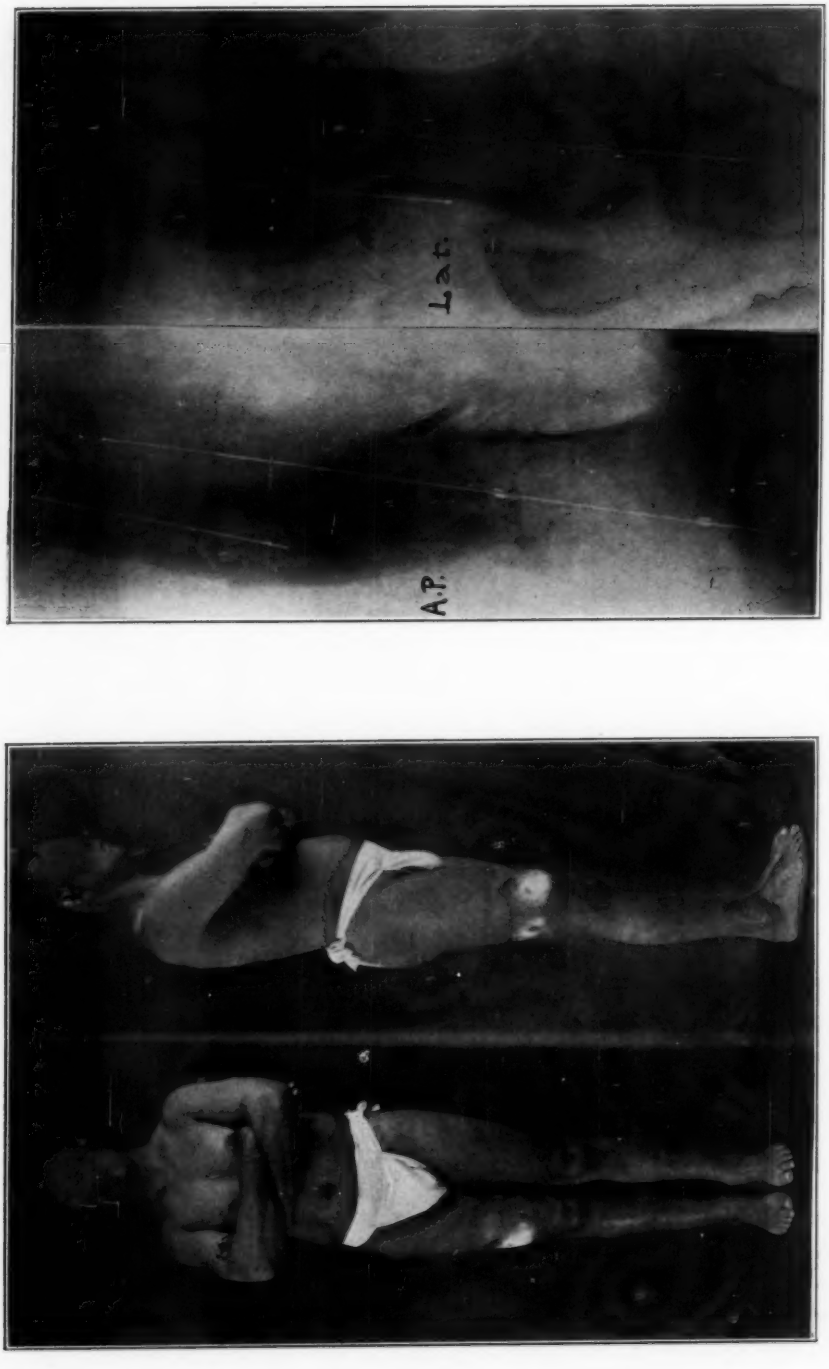

FIG. 2

Correction obtained after operation.

Since his discharge from the hospital, the patient has had marked increase in the function of the knee, almost to normal. Both legs are of the same length and the patient walks without pain.

The advantages claimed are that because of the splintering of the bone and because of the subperiosteal nature of the operation, the tendency toward callus formation is increased and the danger of non-union diminished. In addition, the periosteum itself acts in the nature of an internal splint and permits of correction of the deformity after the operation is finished. The use of a tourniquet is doubtless of great value in preventing the dreaded complication of fat embolism. Kirschner has advocated the use of this operation in all types of bone deformities. It seems however, that for the simple deformity in one plane, due to rickets, etc., this operation is somewhat too extensive to replace the simpler and equally efficient linear osteotomies. This operation may be employed most advantageously in cases where there is a double angulation of the bone, extending over some distance, and where it is desirable to avoid the shortening that would be caused by removing a large wedge. It may similarly be used in cases where non-union is feared, provided the angulation has not occurred in the region of the main nutrient artery.

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MULTIPLE EPIPHYSEAL DYSTROPHY

Case Report

BY WILLIAM ARTHUR CLARK, A.M., M.D., F.A.C.S., PASADENA, CALIF.

The following case seems sufficiently rare to justify reporting:

The patient, I. M., is a Mexican woman, aged forty-four. The complaint which brought her to the clinic was a bad limp in the left leg and deformity of the left knee and both elbows.

Family History: Mother died at thirty-two from "heart trouble". Father living at eighty-seven and well. One sister died following an operation on her throat. One brother died of pneumonia, one died of a "fever", one was killed. Two brothers living and well. No deformities of any kind in the family.

Personal History: At two years of age she had a severe attack of small-pox. Soon after this she had swelling and tumors on the knees and elbows. It was three years

Fig. 1

Without weight-bearing on left leg.

Fig. 2

With full weight on left leg. The cross marks the position of the patella. The prominent point in front is the internal condyle.

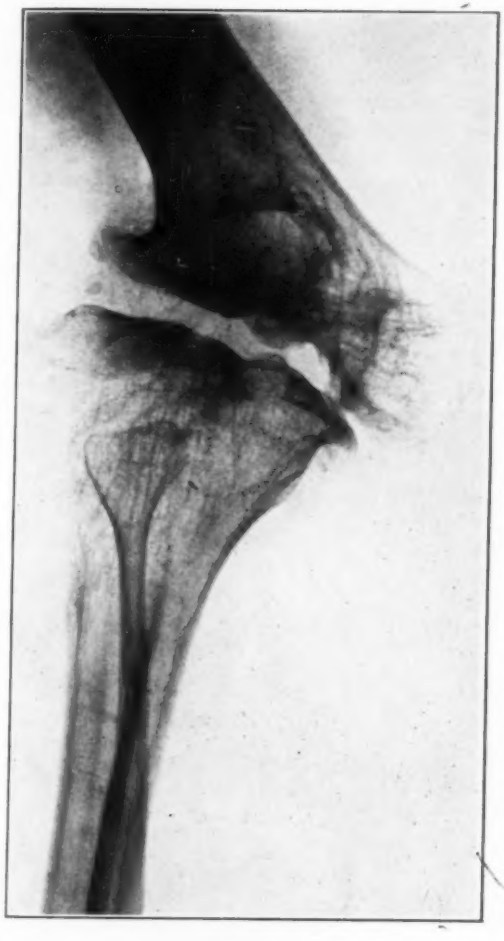

FIG. 3

Roentgen ray of the knee, showing loose bodies, areas of sclerosis and rough irregular joint surfaces.

before she could walk after the attack of small-pox. She had been walking normally before the attack. During the small-pox she lost her right eye; she describes it as "bursting of the eye-ball". Deformity of the elbows and left knee came on following the swelling of these joints after small-pox, and became gradually worse as she grew up. She has had five children, all healthy, the youngest seven years old. Since the last baby she has had one miscarriage. Her husband deserted her and she has recently heard that he is sick. When forty years of age she was in the clinic for chest trouble, at which time a diagnosis of pulmonary tuberculosis was made. She had a negative Wassermann test at that time.

Present Illness: Shortening and limping in the left leg. Deformity and weakness in the left knee. Limited motion, disability and weakness in both elbows. The patient has no pain in these joints, but has occasional aching, especially in damp weather. She walks without artificial support of any kind and does housework. Her general health is good.

Examination: Height five feet, two inches, weight about 115 pounds, general development fairly good. Right eye-ball is absent, left eye normal.

The elbows show irregularity and loss of normal anatomic landmarks. Flexion of the left elbow is possible to seventy degrees, extension to 135 degrees; right elbow, flexion to seventy degrees, extension to 150 degrees. Motion stopped by what feels like a bony block. Hips normal in motion. Left leg seventy-one centimeters in length; right leg seventy-six and five-tenths centimeters. Left leg shows genu valgus at an angle of 140 degrees, knee flexion to 100 degrees, extension to 180 degrees. Ankle dorsiflexion stops at 100 degrees. When not bearing weight, this leg hangs in external rotation of ninety degrees from normal position. Part of this rotation—perhaps a fourth—is at the hip, but most of it is at the knee. The patella faces laterally to her left and the internal condyle of the femur is prominently forward. The foot is at a right angle with the sagittal plane of the body, toes pointing laterally to her left, in moderate varus and severe equinus. On weight-bearing the femur rotates still further outward, bringing the internal condyle forward where it might be mistaken for the patella. Under the weight of the body the knee bends internally and flexes, the patella and quadriceps tendon slip outward and backward because there is no external condyle to hold them. Weight is borne by the ball of the foot and toes, the heel being about four centimeters off the floor. Further

flexion of the knee is prevented by the guy-rope effect of the patella tendon and bony block in the joint. The right leg is normal.

Roentgen rays of the elbows show loss of bone at the internal condyle with slight mesial displacement of the ulna. The proximal end of the ulna is irregular in shape and outline. The head of the radius is flattened and irregular. Rays of the left knee show complete loss of the external condyle of the femur, up to and perhaps a trifle above the level of the epiphyseal line. The joint surfaces are irregular and slightly sclerosed; the general line of the joint is at an angle of thirty-eight degrees with the axis of the femur. The normal for this angle is about eighty degrees.

The blood Wassermann test is negative.

Treatment: The patient refused surgery and refused having a knee brace made.

Comment: The only other cases of this nature which the author has found in the literature are those of Eikenbary[1]. He reported three cases,

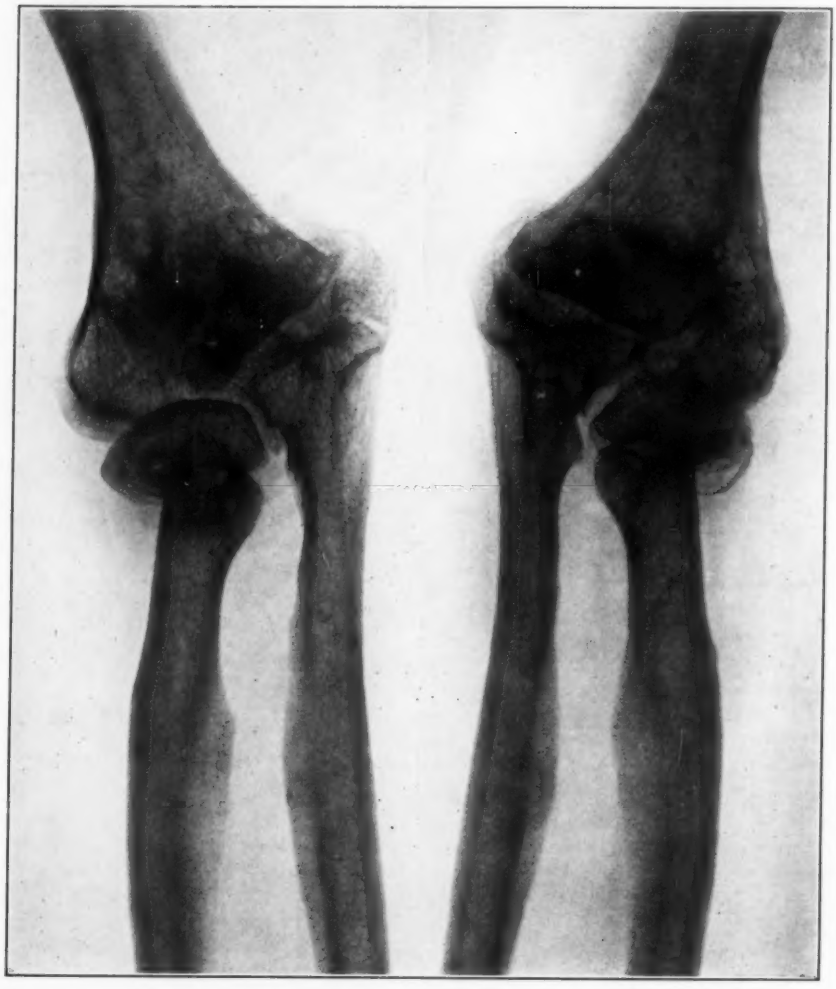

FIG. 4
Both elbows.

all in one family, which he considered probably of luetic origin. His cases were all younger than the one reported above and the roentgen rays of some of the affected joints showed rougher and more jagged irregularities.

On the history of onset in infancy it seems that Charcot joints and syringomyelia can be ruled out. The history of small-pox may be a coincidence, but we cannot overlook the statement of Osler[2], that in complications of small-pox "Arthritis may occur, usually in the period of desquamation, and may pass on to suppuration. Acute necrosis of the bone is sometimes met with." These roentgen rays do not look like the final result of a suppurating joint. It is not probable that a suppurative arthritis would spare one condyle and destroy another. A syphilitic arthropathy might do it. Holmes and Ruggles[3] in discussing syphilis of the bones state that "a juxta-epiphyseal lesion is rather common in children. It starts in the diaphysis near the epiphyseal line. It is characterized first by an irregular loss of substance near the epiphyseal line. This area later becomes sclerosed. Finally there is an angulation of the plane of the epiphysis on the shaft due to contracture of the diseased area or to interference with growth." Von Hippel[4] found that fifty-six per cent. of hereditary syphilitics show joint lesions. Elmer[5] reports a case of complete absorption of both hips, one of which drained for twenty-two months, in a girl of thirteen who had most of the objective signs of tabes dorsalis.

By a process of elimination, then, rather than by specific tests, it is concluded that this case is one of syphilitic origin.

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HEREDITARY DEFORMING CHONDRODYSPLASIA

(Multiple cartilaginous exostoses)

A Report of Three Cases in one Family

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Presbyterian Hospital

The familial incidence of this deforming disease has been quite thoroughly demonstrated by Ehrenfried[1, 2], Reinecke[3], Percy[4], and others.

In Ehrenfried's series of 236 cases, direct heredity was found in 176. Of these, sixty-three cases were in ten families. Reinecke investigated thirty affected families and traced the disease back through two, three, four, and five generations. Percy reported one family in which there were cases running through four generations.

Locke[5] in a paper in "Oxford Medicine" calls attention to the fact that transmission is through the male more often than through the female, and that there is no case on record in which transmission has taken place through an unaffected male, though the malady may be passed on by an unaffected female. The inheritance, however, is usually immediate, that is, from affected parent to offspring.

In the family herewith reported, the youngest daughter, age seventeen, was referred to the writer for diagnosis on October 14, 1927. Recognizing the familial character of the disease, the writer questioned the patient carefully about her family. She stated that her father, age forty, her sister, age eighteen, and her brother, age twenty, were all alive and well; and that her mother died in 1925 at the age of thirty-five, following an operation for a recurrent tumor of the left clavicle. Becoming interested in the case and wishing to present the patient at one of the weekly clinics of the School of Tropical Medicine, a trip was made into the country to see the physician (Dr. R. Sifre) who had operated on the mother, and also to examine the patient's brother, sister, and father. Dr. Sifre had diagnosed the mother's condition as malignant osteochondroma of scapula, with involvement of left acromion process and outer extremity of left clavicle. He operated first in 1920, excising the tumor, but the growth recurred fairly promptly, as it did again after a second operation some time later. At the third operation, September 1925, an extensive invasive neoplasm was found. Radical removal was attempted, but the patient died on the table. No microscopic examination of the tumor was made.

A visit to the home of the family revealed the fact that both the brother and sister had the same multiple exostoses as our patient, but that the father appeared to have none. All four were induced to come into the Presbyterian Hospital for complete x-ray examinations of skeletal system, and

FIG. 1

Knee joints: Case 1, B. C. (father). Apparently normal bones.

FIG. 2

Knee joints: Case 2, B. C. deQ. Multiple exostoses on femora, tibiae, and fibulae.

the three showing positive findings (brother and two sisters) attended the Saturday Clinic at the School of Tropical Medicine, on January 14, 1928. The histories of the four members of the family, father, son, and two daughters, follow:

CASE 1. B. C., (father) Vega Alta, P. R. White male, age forty. Has no complaint; came to hospital for examination and x-ray at request of doctor. Does not recall that any of his family ever suffered from any bony tumors. Physical examination shows a well nourished, healthy male; height, sixty-five inches, weight 130 pounds. Thorax and abdomen negative; no exostoses can be felt, and x-ray shows normal bones. (See Figure 1.)

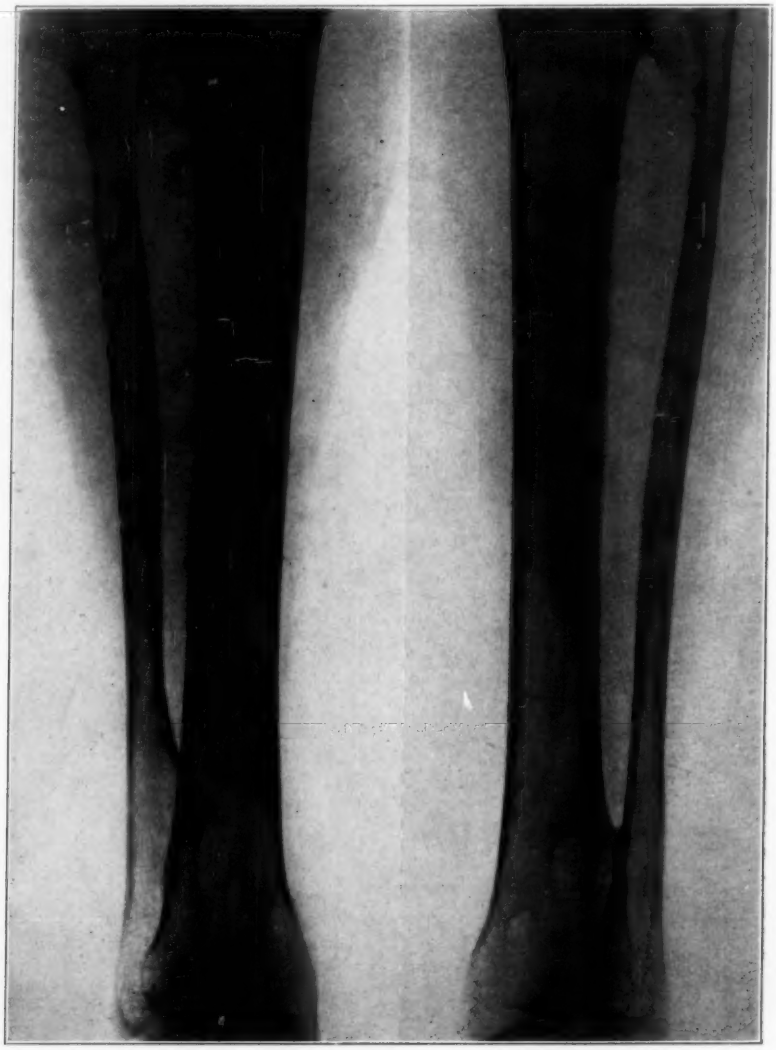

FIG. 3

Lower extremities: Case 2, B. C. deQ. Multiple exostoses at ends of tibiae and fibulae.

CASE 2. B. C. deQ., San Juan, P. R. White female, age seventeen. (First case seen.)

Past History: Usual childhood diseases. Appendectomy in 1927.

Marital and menstrual history: Menses began at twelve years, regular every month, scanty in amount. Married one and a half years, no pregnancies.

Present Illness: Complains of (1) diffuse tumor masses in several portions of body, in relation with bony tissues and small joints (2) deformities of fingers, and (3) recurrent attacks of shooting, lancinating pain in precordial region. At the age of eight she first noticed a small deforming tumor involving the first and second phalangeal joint of middle finger of right hand. As long as she can remember all of her fingers have been of equal length. In March 1927, while convalescing from an appendectomy in another hospital, she noticed bony projections around her knees, thighs, ankles, and sternum, which were not painful.

Physical examination: Short, well nourished female. Height fifty-eight inches, weight 115 pounds. Head, neck, heart, and lungs are negative. Scar in right rectus below umbilicus.

Skeletal system: Small bony projection palpable below left sternoclavicular joint, along upper surfaces of both clavicles, and on outer surface of third and fourth ribs in

FIG. 4

Hands and wrists: Case 2, B. C. deQ. Exostoses of radii and deformity of fingers.

left anterior axillary line. Humeri are apparently normal; both wrists are wide and irregular in outline, and normal bony landmarks are disturbed. Left hand is normal except that index, middle, and ring fingers are of equal length. Right hand has a small tumor mass palpable in first and second phalangeal joint of middle finger causing extreme adduction of distal phalanx and limiting flexion and extension. Metacarpophalangeal joint of ring finger is thick. Bony projections are palpable at distal ends of both femora, and at upper and distal ends of both tibiae and fibulae. The toes of left foot are of equal length and middle toe of right foot is shorter than its fellows.

X-ray examination: Exostoses are noted on phalanges, metacarpal and metatarsal bones, tibiae, fibulae, femora, radii, ulnae, and humeri. Chest plates do not show exostoses noted on physical examination, and skull is negative (See Figures 2, 3 and 4).

Laboratory data: Urine is negative, including Bence-Jones protein reaction. Feces positive for ova of hookworm and trichuris trichiura. Kahn test on blood serum negative. Red blood cells 4,000,000; white blood cells 8,800; hemoglobin, 75 per cent Differential count:—

Polymorphonuclear neutrophils	46 per cent.
Polymorphonuclear eosinophils	10 per cent.
Small lymphocytes	42 per cent.
Large lymphocytes	2 per cent.

CASE 3. C. C., Vega Alta, P. R. White female, age eighteen, single.

Past History: Usual childhood diseases. No other illnesses. Menstruation began at twelve years; regular, but profuse and painful.

Present history: About one year ago, noticing that her brother had a bony projection from his arm that was distinctly visible, she began to feel her own bones and found a similar projection from her left humerus about seven centimeters from shoulder joint. This had caused no discomfort and she came for examination only at doctor's request.

Physical examination: Short, well nourished female. Height fifty-seven inches, weight ninety-six pounds. Head, neck, heart, lungs, and abdomen negative. Reflexes normal.

Skeletal system: Left arm shows bony projection from humerus about four centimeters from shoulder joint, otherwise normal. In lower extremities, bony projections are palpable at distal ends of both femora and proximal ends of both tibiae and fibulae. The second toe of left foot is definitely shorter than its fellows.

X-ray shows definite exostoses of left humerus, both femora, tibiae, and fibulae (See Figures 5 and 6).

Laboratory data: Urine is negative, including Bence-Jones protein reaction. Blood: red blood cells 5,900,000; white blood cells 8,400; hemoglobin 77 per cent. Differential count:—

Polymorphonuclear neutrophils	74 per cent.
Small lymphocytes	14 per cent.
Large lymphocytes	7 per cent.
Transitional and mononuclear cells	5 per cent.

CASE 4. G. C., Vega Alta, P. R. White male, age twenty, single.

Past history: Had usual childhood diseases; no other illnesses.

Present history: At age of seven he noticed a hard swelling on the outer aspect of right humerus. It has not increased in size nor is it painful, however he feels that it was closer to the joint when it started than it is now. He has no complaint. He came for examination at doctor's request.

Physical examination: Short, well nourished male. Height sixty inches, weight 105 pounds. Head, neck, lungs, heart, abdomen, negative. Reflexes normal.

Skeletal System: Large, hard, bony tumor mass is felt on outside of shaft of right humerus about eight centimeters from shoulder joint. Right elbow joint is one centimeter wider than left. There is a small bony projection from shaft of left humerus just below shoulder joint; hands are normal. Bony projections are palpable at distal end of both femora and proximal ends of both tibiae and fibulae, and at distal end of right tibia. Feet show two middle toes of left foot shorter than their fellows.

FIG. 5

Knee joints: Case 3, C. C. Multiple exostoses on femora, tibiae, and fibulae.

FIG. 6

Left humerus: Case 3, C. C. Exostoses just below shoulder joint, and rarefaction of distal end of bone.

FIG. 7

Knee joints: Case 4, G. C. Multiple exostoses on femora, tibiae, and fibulae.

FIG. 8

Right humerus: Case 4, G. C. Large exostoses near middle of shaft, and rarefaction of distal end of bone.

X-ray examination: Shows definite exostoses of both humeri, femora, tibiae, and fibulae (See Figures 7 and 8).

Laboratory data: Urine is negative, including Bence-Jones protein reaction. Blood: red blood cells, 4,750,000; white blood cells, 9,100; hemoglobin, 63 per cent. Differential count:—

Polymorphonuclear neutrophils	70 per cent.
Small lymphocytes	21 per cent.
Large lymphocytes	5 per cent.
Transitional and mononuclear cells	4 per cent.

DISCUSSION

We have here a family of one male and two females with multiple exostoses. The father shows no evidence of the disease. Since the inheritance is usually immediate, from parent to offspring, and no cases of transmission through an unaffected male are recorded, we may fairly assume that these people inherited the disease from their mother. The malignant osteochondroma of which the mother died might very well have had its origin in an exostosis. Ehrenfried[2] states that the most frequent and most serious complication of hereditary deforming chondrodysplasia is the development of a rapidly growing or malignant osteocartilaginous tumor in one of the exostoses. He estimates that this complication has occurred in about five per cent. of the reported cases. The change may develop between the ages of eleven and fifty-nine, but it usually occurs soon after skeletal growth has ceased,—that is, between twenty-five and thirty-five years. The patient referred to above was first operated on at the age of thirty and died five years later.

FIG. 9

Cases 4, 3, and 2. Arranged according to age from left to right.

It is perhaps significant that only one of the three young people showing multiple cartilaginous exostoses complained of any symptoms, and in this case it is doubtful if the shooting precordial pain was referable to the tumor.

So far as the writer knows, these three cases are the first examples of hereditary deforming chondrodysplasia to be reported from Porto Rico.

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KÖHLER'S DISEASE OF THE PATELLA*

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In Köhler's original paper,[1] describing the condition found in the tarsal scaphoid now generally known as "Köhler's disease" or "Isolated disease of the scaphoid", he noted an abnormality of the patellae in one of the three cases reported. Since the publication of this paper there have been many cases of the scaphoid condition reported but few of the patellar variety.

For this reason the findings in such a case will be of interest, especially since there are now available pathologic findings in what the writer believes to be an allied condition,—Legg's disease of the hip. In this connection it is also interesting to note that Köhler, in his description of the x-ray appearance of the patella, makes this observation: "I have once more examined my collection of roentgenograms, which I have accumulated in nine years, with reference to similar affections, and have found only one pathological picture which might belong to the syndrome described by me. This concerns cases which clinically simulated a tuberculous coxitis, but which healed remarkably quickly and well, so that I was skeptical as to whether this represented a tuberculous process."

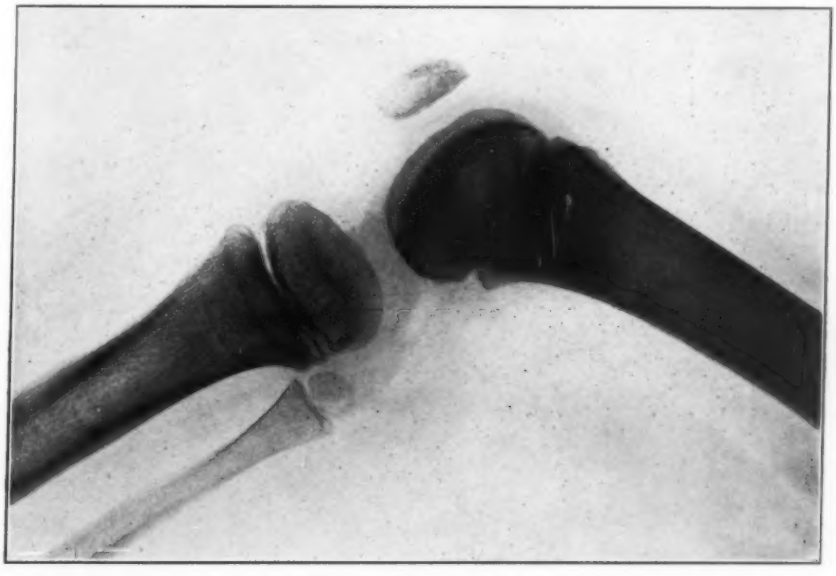

FIG. 1

Lateral view of the patella on the unaffected side, showing normal progress of ossification.

*From Orthopaedic Department, New York Post-Graduate Medical School and Hospital.

M. C., age seven years, came to the clinic at the Post-Graduate Hospital, complaining of pain and disability of the left knee following a fall upon the knee seven weeks before. The past history disclosed that the knee had become tender and swollen thirteen months ago following an injury; that it was incised and continued to drain up to a year ago. The knee had completely recovered some months before the onset of the present condition.

Physical examination showed locally: The left knee was held in flexion of 150 degrees, further extension being limited by spasm of the hamstrings. There was a "doughy" infiltration of the periarticular tissue with little increase of synovial fluid. The surface temperature was elevated. A provisional diagnosis of synovial tuberculosis of the knee was made and the case referred for x-ray, when the diagnosis of Köhler's disease was apparent. Because of the disintegration of the patella and to prevent further separation of the fragments, the child was admitted to the hospital, February 6, 1928, for the insertion of a purse-string suture about the patella.

At operation the findings were: A much thickened and apparently chronically inflamed synovia; slight increase of fluid; the patella elongated and very soft, almost cartilaginous in consistency. A section for study was removed. The pathologic report showed no evidence of osteitis. The bone was everywhere invaded by cartilage. The appearance corresponded to that described in microscopic examination of sections of the femoral head affected by Legg's disease[2]. The blood count at this time showed:

Polymorphonuclear neutrophils	47 per cent.
Lymphocytes	47 per cent.
Transitional cells	2 per cent.
Mononuclear cells	4 per cent.

Since operation the leg has been immobilized in plaster. Successive x-rays show very little change. There has been no further separation of the fragments.

The points of interest in this case are:

(1) The association of a chronic inflammatory process as a possible etiologic factor.

(2) The absence of any evidence that the bone condition itself was inflammatory in character.

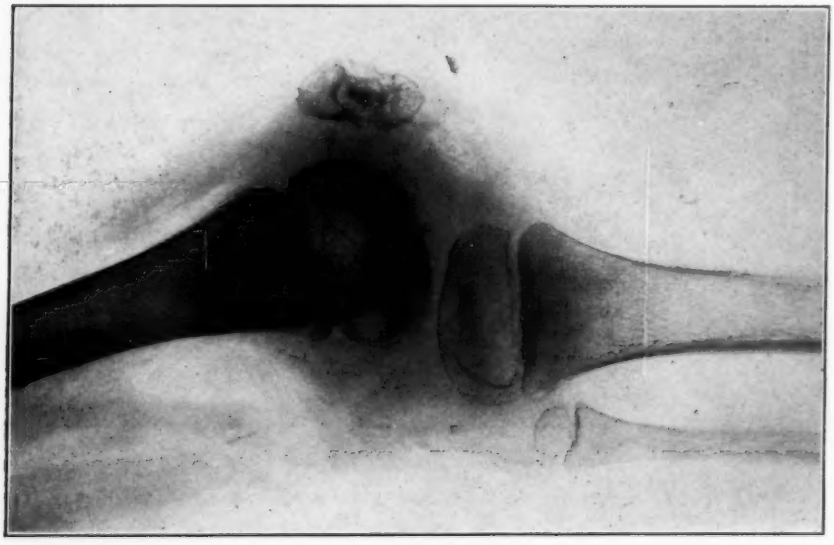

FIG. 2

Lateral view of the patella on the affected side, showing fragmentation of patella.

FIG. 3

Low-power view of microscopic section, showing infiltration of bone by bands of cartilage indicated by the lighter areas.

(3) The elongation of the bone which was probably in adaptation to the axial strain to which it was subjected in its softened condition.

This condition is apparently what is termed an epiphysitis—for want of a better name—by which is understood a disturbance in the normal development of a bone, occurring at the age when it is in process of ossification. If the condition occurring in the tarsal scaphoid is of similar pathology, the x-ray appearance here differs because the bone is subjected to compression rather than axial traction. This is in line with the conclusions formed from clinical observation of the tarsal condition published in a previous paper.[3]

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BONE MARROW IN THE PLEURAL VEINS

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Under normal conditions red blood cells and polymorphonuclear leucocytes get from their original place of manufacture, the bone marrow, into the veins by a much veiled process. It is said that the capillaries of the bone marrow allow them an easier egress because of their loose, more open structure and because of some peculiar chemical influence. It may be that altered vascular pressure, suction action of breathing, hydraulic and atmospheric pressure have their influence. Possibly the condition called "loss of an inhibitory force" is the instrument. It may be that some internal secretion is the chemical force called on, in time of need, to allow them out of prison. This will possibly explain the "loss of some inhibitory force".

The vascular condition, whether primarily due to cardiovascular disease or due to toxins, has experimental backing to indicate its influence in allowing marrow to get away. Drinker, Drinker and Lund say, "Early experiments proved a very efficient vasomotor control of marrow vessels, constrictor in type. Constriction (by adrenin) resulted in reduction in the number of nucleated red blood cells and myelocytes found in the effluent blood. Mechanical measures alone will not disturb the integrity of the normal bone marrow vasculature. Carbon monoxide caused an outflow of marrow cells and nucleated red blood cells under perfusion. Increase in blood movement alone will not dislocate marrow cells. Poisoning with saponin injures the capillaries. Perfusion now causes a large escape of all sorts of young cells into the circulation. The megalokaryocytes are filtered out in the lung capillaries."

Whichever of these causes is potent, it need be very slight (microscopic) for the exit of individual cells. It needs to be greater in the case of whole marrow. I have described whole marrow, fat, and cells getting out of the rib into the intercostal veins under pathological conditions. Now I trace it farther,—into the pleural veins. Single marrow cells have been seen by me and others in the lung. They have been found by some in the spleen and kidneys.

In 500 autopsies I have seen whole marrow in the intercostal veins of 135 cases. In one I saw it in the pleural vein. The two most common conditions under which it is found are cardiovascular disease with chronic passive congestion and oedema and in infectious and toxic cases—hydrophobia, tetanus, typhoid, streptococcus, staphylococcus, and tuberculous infections,—ergotol, carbon monoxide, and cantharides poisoning, uraemia, exophthalmic goitre, and in cases of fat embolism. The occurrence of toxins and chronic passive congestion is often found in the same case. In both

conditions oedema was extensive. But it is found in cases of sudden traumatic death without an antecedent toxic period. It would appear that oedema of cardiovascular disease and infection most commonly influence this exit of whole marrow. I have seen it in veins about other bones than the rib,—tibia and vertebra. It has never been seen by me in arteries. Although I have found giant cells of marrow in the lungs, I have never seen whole marrow further removed from the rib than the pleura. Age does

FIG. 1
Longitudinal section of pleural vein adjoining rib. Marrow with fat.

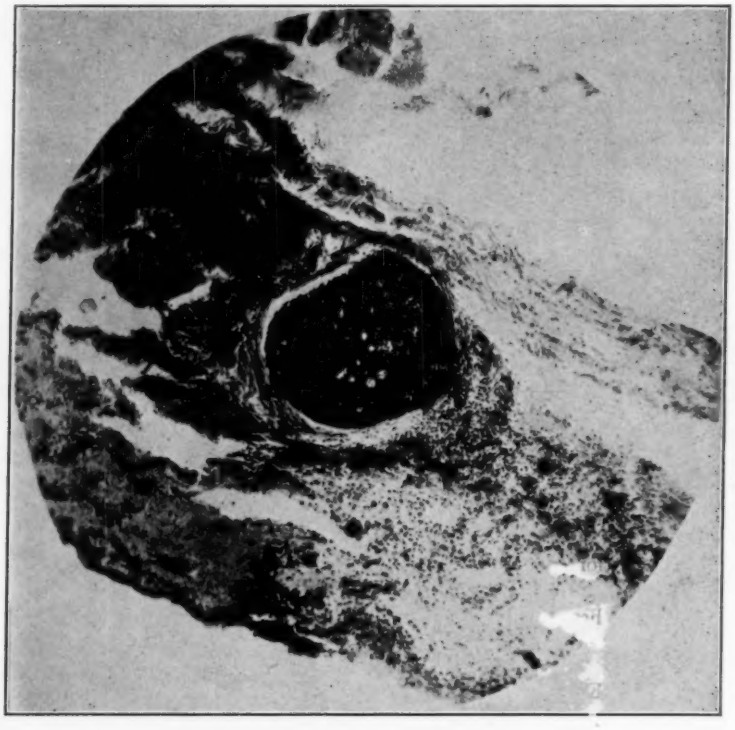

FIG. 2
Cross section of pleural vein at rib. Fatty marrow filling vein.

not seem to especially influence the condition. It is seen evenly distributed in patients from six months of age up to the eighty-sixth year. In fifteen cases marrow was seen in the veins before the twelfth year.

CASE REPORT

Woman—aged twenty-two years.

The cause of death was septicaemia following infection of the arm. Pneumonia and pleurisy developed. The polymorphonuclear leucocyte count rapidly increased from 21,600 to 46,000. The final count was: white cells 46,000; polymorphonuclears 92 per cent., small round cells 5 per cent., large 3 per cent.; hemoglobin 65 per cent.

Pathology: Anatomical diagnosis: cellulitis, left arm with multiple recent operative wounds; multiple abscesses in lung; bronchopneumonia, bilateral; acute vegetative endocarditis, mitral valve; multiple small abscesses in right kidney; acute nephritis; marked dilatation of right side of heart; cloudy swelling of myocardium and liver; acute splenic tumor; early arteriosclerosis of aorta; submucous hemorrhages in fundus of stomach; multiple cysts of left ovary; scar in midline of abdominal wall above symphysis pubis.

(The rib is removed as a routine in pathological examination.)

The rib is dense and narrow, measuring one and five-tenths by seven-tenths centimeters.

Microscopic Examination: Hyperaemic; periosteum very cellular and congested; cortical bone erratically arranged and dense. Haversian canals at periosteum of the

upper border are wide, coalescent, and open at the periosteum; elsewhere they are very narrow. The wider ones contain many cells and coagulated serum. Many lacunae are enlarged and contain divided and dividing bone cells. The trabeculae are swollen (oedematous) and show clefts between lamellae; their borders are irregular from lacunar and vital absorption. There are a few osteoclasts in Howship's lacunae. There are many enlarged lacunae with enlarged and dividing bone cells at the borders of the cancelli. All the bone cells stain well. Marrow: hyperaemic, oedematous, very little fat; reversion to the embryonal type—hematoblasts, megalokaryocytes, large and small cells densely massed;— many polymorphonuclear leucocytes. It resembles granulation tissue.

The attached pleura is hyperaemic, oedematous, and contains many large endothelial cells and plasma cells. At one place there is an organizing fibrinous pleurisy including the pleural vein. The vein is cut longitudinally in some sections. It is plugged with bone marrow,—not to be differentiated in any way from the marrow as seen in the rib.

The marrow of the rib here involved appears as what is commonly described as "hyperplastic". In my description, I use the term "granulation tissue". It is a vascular embryonal marrow with little fat, detritus, and old blood pigment. It is congested with blood, the capillaries appearing injected and numerous. There are many large cells like the reticulo-endothelial cells and some interspersed smaller cells like lymphocytes. In any other part of the body, it would be called "granuloma". The intercostal and pleural veins contain the same material exactly as it appears in the bone. In longitudinal sect[illegible] the pleural vein is plugged with this. Surrounding the vein is fibrin with round-cell infiltration and new capillaries of an organizing pleurisy. Some of the marrow cells [illegible] reached the lung and plug the capillaries.

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UNUSUAL BONY GROWTH ORIGINATING FROM OS CALCIS*

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A white male, aged seven, began to limp during the summer of 1928, the limp originating in the right foot. There has been an increase in the disability, accompanied by pain in the outer part of the sole at the anterior portion of the os calcis. There is nothing in the previous history to interest us.

Clinical Examination:—Well nourished, healthy-looking male, with a marked limp, the limp being of the equinus type. There is, on the sole of the foot at the outer border slightly posterior and internal to the outer edge of the cuboid, a mass about one inch in diameter, and seemingly almost as thick, involving the deeper tissues of the sole. A bony projection from the os calcis could be felt in the sole, extending toward the center of the soft-tissue growth. A diagnosis of exostosis accompanied by a large protective bursa was made.

X-ray disclosed a projection, about three-fourths of an inch in length and three-eighths of an inch in diameter, from the anterior inferior surface of the os calcis.

Operation at the Samaritan Hospital, March 28, 1929: External lateral incision; growth exposed, and removed in two pieces; wound closed; foot encased in plaster-of-Paris, in the varus position. Cast removed April 18, 1929; wound fully healed, bursa about one-fourth of its former size. One week later child was walking without any evidence of disability or pain, the bursa by this time having practically disappeared.

FIG. 1

Unusual bony projection from anterior part of os calcis.

*From the Orthopaedic Department of Temple University.

A projection from the os calcis in this location is extremely unusual, particularly in a child. On first thought an exostosis was considered, although there was nothing to point to either a traumatic or toxic origin, as there were no other growths that could be found. Congenital exostosis was ruled out, as these rarely are single. There was a facet on the upper part of the growth at its junction with the os calcis. While incomplete, it offered either one of two explanations:—(1) an exostosis that, through the trauma of weight-bearing, had fractured off and formed a facet from the motion imparted in locomotion; (2) an unusual supernumerary bone. Dwight[1] describes nothing that could be even distantly related to this structure. Other literature consulted was equally barren.

1. Dwight, Thomas: Variations of the Bones of the Hand and Foot. Philadelphia, J. B. Lippincott Co., 1907.

A STUDY OF THE KYPHOTIC SPINAL COLUMN

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From our preliminary study of the bodies of the vertebrae in normal spinal columns it has been possible to develop a method for quantitative study of atypical conditions.[1] In this report we discuss the bodies of the thoracico-lumbar vertebrae in kyphotic columns. The group selected for detailed study consists of those columns which were kyphotic at autopsy but show no anomaly, vertebral fusion, or other abnormal condition after maceration. Such a selection is necessary in order that we may study those features of the kyphotic column not obviously resulting from pathological conditions producing rigidity by fusion or localized defect. Among the 1300 columns housed in this laboratory, Dr. Todd picked out forty-two having, before maceration, a marked kyphosis of the upper or mid-thoracic region. After maceration, seventeen of these columns showed fusions of two or more vertebrae and seven more proved otherwise unsuitable. Of the remaining eighteen, one was discarded because it had eighteen thoracico-lumbar vertebrae. Hence seventeen were used for this study.

These seventeen columns belonged to individuals ranging in age from twenty-seven to eighty-four years. Nine of them were below sixty years of age. There were ten male whites, three male negroes, three female whites and one female negro. It is obvious that no inferences relating to age, sex, or race can be drawn from such a selection, but, studied as individuals, the number is large enough to promise instructive results. It is even possible to group the ten male whites and so to emphasize the expression of certain physical tendencies. Naturally our attention has been focused upon dimensions of the vertebral body. Ventral and dorsal heights of the dried vertebrae have been measured by methods described in previous studies.[1] Causes of death and general condition of the skeletons received attention on account of the possibility of diseases or diatheses common to the group.

Of the seventeen cadavera, death in five was due to pulmonary tuberculosis. Three of these were male negroes and two were male whites. Of the remaining cases, no one cause predominates even to this degree. The group shows a wide variety of both chronic and acute ailments. Two skeletal records only show some marked atypical condition in other parts of the skeleton. No. 1442 has a split neural arch on the first sacral vertebra with a tendency toward separation from the other sacral vertebrae. No. 1548 has a unilateral non-fusion of the neural arch of the fifth lumbar.

In the group as a whole the vertebrae do not show any acceleration of age-linked features. The older skeletons of course show texture changes characteristic of their age, but the younger ones are quite typical for their years. We are dealing, therefore, with a group of skeletons normal in bone growth and skeletal condition.

In our detailed analysis we turn first to the group of ten male whites. The average age of this group is fifty-seven years with a range from thirty-eight to seventy-eight years inclusive. Six are below sixty years of age. Table I compares the ventral and dorsal heights of the bodies of the vertebrae with those of our group of male whites described in our first series.[1]

TABLE I

COMPARISON BETWEEN TYPICAL MALE WHITE COLUMNS AND THOSE SHOWING MARKED KYPHOSIS

K—Kyphotic male White—10 columns, average age 57.0 years
T—Typical male White—43 columns, average age 49.7 years

VENTRAL HEIGHT

	Cervical	*Per cent.*	*Thoracic*	*Per cent.*	*Lumbar*	*Per cent.*	*Total*	*Atlas-sacrum*
K.	108.2 mm.	22.12	236.4 mm.	48.33	144.5 mm.	29.54	489.1 mm.	588.4 mm.
T.	103.7 mm.	21.79	234.2 mm.	49.22	137.9 mm.	28.98	475.8 mm.	596.0 mm.
		+0.33		−0.89		+0.53		

DORSAL HEIGHT

K.	105.4 mm.	21.14	259.0 mm.	51.96	134.1 mm.	26.90	498.5 mm.
T.	102.8 mm.	21.15	248.6 mm.	53.11	134.7 mm.	27.71	486.1 mm.
		−0.01		−1.15		−0.81	

On the average the typical male white column is shorter by 13.3 mm. in ventral height and by 12.4 mm. in dorsal height than the column showing marked kyphosis. Of the ten columns from which the averages were computed only one kyphotic column was shorter than the average for the typical column, and this difference was but 0.8 mm. In dorsal height two kyphotics were slightly less than the average typical. A comparison of our two averages shows a difference in the same direction, both dorsally and ventrally, of practically the same amount almost consistently distributed. Hence the kyphotic group really have longer columns despite possibilities of error in measuring. On the other hand the average atlas-sacral length is less in the kyphotic spine than in the typical columns. This is a green dimension and includes thickness of discs. It is interesting to speculate as to what rôle soft parts played in the formation of the kyphotic curvatures since the summated height of dried bodies is greater in proportion in the kyphotic group and the atlas-sacral length is less. We have little information upon which to rely, as we have no green dimensions of the discs of the kyphotic group and but two roentgenograms.

When we now consider the three regions of the kyphotic column we see that the percentage of length of the cervical region upon the entire column differs but little between the two series either in dorsal or ventral measurement. The differences between the two series in thoracic and lumbar dimensions are merely confusing because some units of a region compensate for others by a change in the opposite direction. It is therefore plain that we must seek expression of the differences in a comparison of dorsal and ventral height in each of the thoracico-lumbar vertebrae (Table II).

TABLE II

PERCENTAGE OF DORSAL UPON VENTRAL CENTRUM HEIGHT

	Average values			*Summation*
	Typical (T)	*Kyphotic (K)*	*K-T*	
T1	107.7 per cent.	105.8 per cent.	−1.9 per cent.	
T2	101.2 " "	101.0 " "	−0.2 " "	
T3	101.0 " "	102.6 " "	+1.6 " "	
T4	104.4 " "	108.5 " "	+4.1 " "	
T5	105.8 " "	111.3 " "	+5.5 " "	
T6	110.1 " "	118.9 " "	+8.8 " "	
T7	110.0 " "	122.9 " "	+12.9 " "	
T8	111.2 " "	114.3 " "	+3.1 " "	
T9	110.1 " "	110.6 " "	+0.5 " "	
T10	107.5 " "	110.8 " "	+3.3 " "	
T11	111.8 " "	112.4 " "	+0.6 " "	
T12	111.4 " "	106.4 " "	−5.0 " "	+51.0 per cent.
L1	106.4 " "	102.3 " "	−4.1 " "	
L2	101.2 " "	96.0 " "	−5.2 " "	
L3	96.8 " "	93.9 " "	−2.9 " "	
L4	93.9 " "	93.4 " "	−0.5 " "	
L5	82.8 " "	79.1 " "	−3.7 " "	−21.2 per cent.

The figures of Table II are reproduced in graphic form in Chart I. The exaggerated curve of the kyphotics is particularly concentrated in the sixth and seventh thoracic segments. The compensatory lordosis of the lower thoracic and the lumbar regions is quite apparent and reaches one segment higher in the kyphotic than in the typical column. Nevertheless, and in spite of these peculiar features, the kyphotic curves follow those of the typical column, the essential difference being a greater fluctuation and irregularity in the former. The lordosis of the lumbar region, however, is far from compensating adequately for the thoracic kyphosis.

We have no figures with which to compare individual vertebrae of the male negroes, female whites and negroes computed on this collection of skeletons. But regardless of age or sex there is, in common with the male whites, a tendency of the kyphotic vertebrae to show irregularity in relationship of dorsal and ventral heights.

In conclusion, we may say that the summated length of the bodies of the vertebrae regardless of age is greater in the average kyphotic than in the typical column. The thoracic kyphosis is not adequately compensated by the lumbar lordosis and the kyphosis is especially marked in the thoracic sixth and seventh vertebrae. These differences demonstrate themselves in

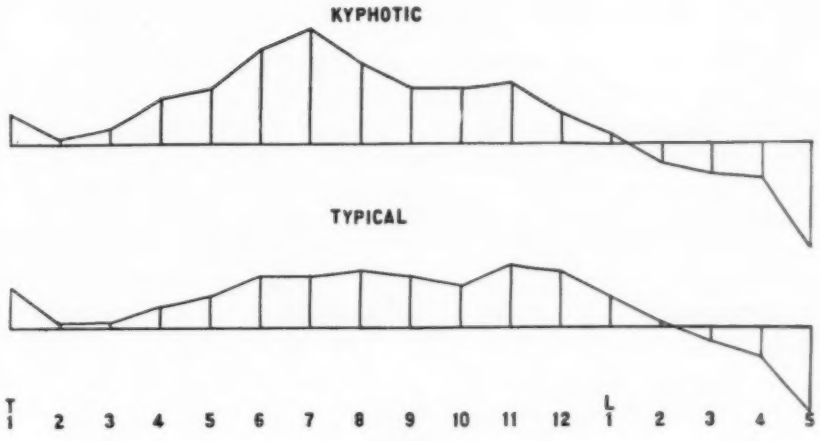

CHART I

AVERAGE CURVATURES OF NORMAL AND KYPHOTIC COLUMNS

The base line represents equal values for dorsal and ventral centrum height of thoracic and lumbar vertebrae. The irregular lines represent percentages of difference of dorsal centrum height from ventral height. The distances correspond exactly with the differences between the figures of columns *K* and *T* in Table II and 100. Note that in the kyphotic graph the irregular line crosses the base one vertebra higher than in the normal column graph.

exaggeration of curvatures, so that the green length from atlas to sacrum including discs is greater in the average typical column than in those with marked kyphosis. The localization of this difference in the mid-thoracic region is emphasized by our investigation of fusions in the group of kyphotics discarded for this study. It is very rare to find fusions in the cervical region, somewhat more common to see them in the lumbar region, but far the greater number occur in the thoracic vertebrae, involving most frequently the sixth to the ninth units inclusive.

How age influences the structure of the column and how far the vertebral bodies change in shape are important problems difficult to solve. Even if the vertebral centra yield to pressure with an assumed shifting of the weight line and consequently decrease in ventral height in the thoracic region as age advances, the fact remains that these kyphotics are longer columns than the average typical ones. It is instructive to note that the group average is seven years older than that of the typical group; and this indicates quite definitely that age is a factor of importance. The relative proportion of soft parts to bone in the three regions of the column is of importance also, but we have found it impossible to solve in practice, because actual measurements are vitiated by bony lippings and the lateral radiogram gives equivocal results of measurement. To pursue the problem further would be futile.

The writer wishes to express her appreciation to Dr. Todd for his careful criticism of this article, and for his kindness in permitting her to use the collection of skeletons in the Hamann Museum for this study.

SUMMARY

1. This study is subsequent to two others upon which it is based.

2. It is an effort to analyze quantitatively the vertebral centra of kyphotic columns which have not yet developed fusion of successive centra or otherwise become pathologically modified.

3. We have not found congenital anomalies necessarily associated with kyphosis, nor have we found such columns presenting age features in advance of their years.

4. Although some columns do become markedly kyphotic even during the fourth decade, the deformity is more rarely found below sixty years than in greater age.

5. Kyphotic columns, again, are potentially long columns, though we would not imply that there is any necessary connection between these two features.

6. The analysis of summated lengths of cervical, thoracic, and lumbar regions is equivocal, whether ventral vertical or dorsal vertical height of centrum is measured. The anomaly must be sought locally.

7. The exaggerated curvature of the kyphotic columns tends to express itself most clearly in the sixth and seventh thoracic vertebrae.

8. Compensatory lordosis of the lower column involves one vertebra more than the normal ventral convexity comprises, namely the first lumbar.

9. The lumbar lordosis is far from compensatory for the thoracic kyphosis.

[1]Todd, T. W. and Pyle, S. I.: Effects of Maceration and Drying upon the Vertebral Column. Am. J. Phys. Anthropol., XII, 303, 1928.

A Quantitative Study of the Vertebral Column by Direct and Roentgenoscopic Methods. Am. J. Phys. Anthropol., XII, 321, 1928.

ACUTE FRACTURES OF THE SHAFT OF THE FEMUR IN CHILDREN

A Report of the Treatment and Results Attained in Eighty-six Acute Fractures of the Shaft of the Femur in Eighty-five Children, With a Résumé of Various Types of Treatment and Results Attained by Other Surgeons

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In an address given in London before the Essex County Council on The Cripple Problem, Sir Robert Jones[1] stated that cripples are on the increase, which is a situation universal; that one of the main reasons for this increase is that little, but important, things are not done at the right time, making it necessary to have big things done later, and even then without relief. In other words, "An ounce of prevention is worth a pound of cure". In many cases, if properly treated, the patients would not be maimed for life and a burden to society. His classification of the causes of most of these deformities was as follows: tuberculosis, rickets, the paralytic group, congenital defects, and the traumatic group. These five groups cover adults as well as children; but in this study only the traumatic group of children will be considered.

This traumatic group concerns us more at the present time than it has in the past, because of the increased use of motor vehicles, speed of locomotion, and the outdoor life—which today the average individual is living more than ever before. This group will be even greater as time goes on and the reasons affect the child as much as the adult. For example, in this series of eighty-five cases, with eighty-six fractures of femur, thirty-six children received fractures of femur by motor-driven vehicles, an average of forty-two and thirty-five one-hundredths per cent. of the total number of cases. In no affliction other than an acute fracture of the femur, is it so important that the little but important things be done immediately following injury, thereby preventing many catastrophes. The crippled child may be handicapped not only physically, but mentally. Even if he is mentally developed he is prevented from progressing in a competitive way with other children. He works under great handicaps and is always an object of pity.

In the presentation of this report the writer had one hope in mind,—by collecting and reviewing several authorities' opinions on treatment and results of fractures of the shaft of the femur in children, some definite

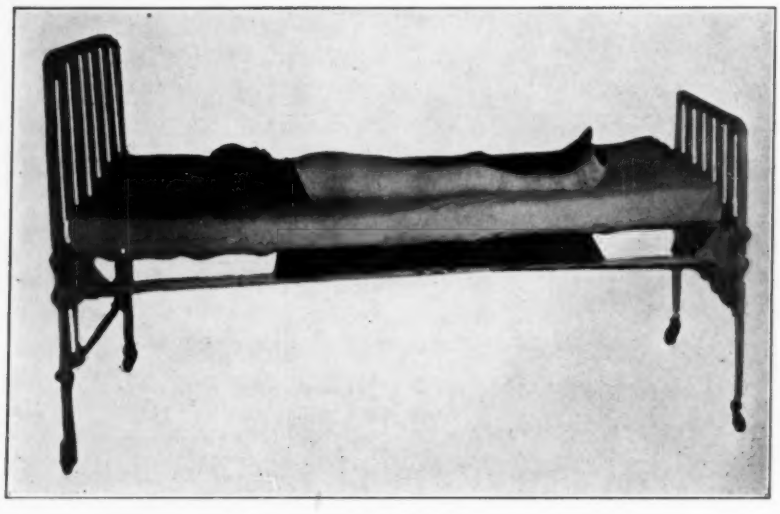

FIG. 1

Type of treatment used in Series *A*, plaster cast; twenty-four cases. Following the administration of an anaesthetic, reduction was accomplished with the aid of the fluoroscope, and plaster cast was applied from the axillae to the base of the toes. Fracture boards were used underneath the patient with the thigh in abduction. The thigh was either elevated or on the bed. These cases averaged 20 days in the hospital and 41.69 days in plaster cast. (See Series *A*.)

conclusions could be reached as to the best technique for the treatment of such fractures. In addition, the writer wished to present a report and review with conclusions of his own cases.

In the consideration of any fracture it is impossible to confine the discussion of the lesion merely to the bone itself, as the surrounding tissues are the more important factors and are responsible for most of the complications. This is especially true when taking up the anatomy and mechanics of a fracture; and the problems of treatment are greatly simplified if these two subjects are thoroughly understood. The object of all treatment is, of course, to put the parts involved into their normal positions and to hold them there while healing is taking place; to have as nearly perfect alignment as possible. If one does not know the normal contour of the bone or bones involved, or the various factors which tend to prevent the normal anatomy from being obtained, it is impossible to handle any fracture intelligently.

With fractures of the femur one must know, not only the anatomy of the bone and relation of the muscles, fascia, blood-vessels and nerves to the bone and to each other, but also the anatomy of the hip and knee joints, and the function of these joints as related to such fractures. A knowledge of the extrinsic and intrinsic forces, which cause the femur to break, which cause deformity after fracture has taken place, and which aid or hinder reduction, is also essential. The physical properties of bone—elasticity and strength—must not be forgotten. No new facts or princi-

ples in the anatomy or mechanics of femur fractures can be given; but this statement is made to emphasize the impossibility of treating fractures without knowing and being familiar with the surrounding structures.

Ashhurst[2] says in the treatment of fractures of the femur in children nothing is more fundamental than the surgeon's knowledge of the intimate connection between the bone and soft structures—the bone's original formation from the soft parts—and the younger the patient, the more intimate is the physical connection between the two. Bones depend for their form on the action of the muscles and the daily use of the limb.

Reviewing the literature on fractures of the shaft of the femur in children, it would seem that there are three outstanding methods of treatment:

A: Plaster cast

B: Plaster cast and traction { adhesive / calipers / Steinmann pins

C: Suspension and extension.

The suspension and extension method (*C*) has several divisions:

Buck's traction

Skeletal traction (calipers or Steinmann pin) with the horizontal or perpendicular position

Horizontal elevation and extension of one or both thighs

Perpendicular suspension and extension of one or both thighs

Thomas splints

Hodgen splints

Bradford frame.

Each method has strong advocates and each method gives excellent results in certain hands. Open reductions are also recommended by a few individuals, but later this form of treatment comes under one of the above heads.

The writer presents a series of eighty-six acute fractures of the shaft of the femur in eighty-five children, who were treated at the Orthopaedic Clinic, Employees' Hospital, Fairfield, Alabama. These cases occurred during the period from January 1920 to January 1926.

These cases were treated in:

Plaster cast,—Series *A*,

Plaster cast and extension,—Series *B*,

Suspension and extension,—Series *C*.

They were observed throughout the entire period of treatment and convalescence, under the personal supervision of the writer and, because each case was closely observed and was given the same individual care, he feels that the summary of these cases will be a good comparison of the different techniques. Each case was under observation until entirely well. Twelve cases were observed over a period of three years following injury and all the others were observed six months to two and a half years following injury. This series of cases is presented as follows:

SUMMARY OF CASES

	Series *A* Plaster Cast 24 cases 24 femora	Series *B* Plaster Cast and Extension 20 cases 20 femora	Series *C* Suspension and Extension 41 cases 42 femora	Total 85 cases 86 femora	General Average
Age	7.16 years	7.8 years	6.8 years		7.25 years
Color	White 15 Negro 9	White 8 Negro 12	White 19 Negro 22	White 42 Negro 43	
Sex	Males 23 Females 1	Males 16 Females 4	Males 32 Females 9	Males 71 Females 14	
Days in Hospital	20	43	46		36.33
Days in Plaster	41.69				41.69
Days in Plaster and Extension		38.3			38.3
Days in Suspension			25.8 Buck's 7.37		33.17
Right Femur	11	9	22	42	
Left Femur	13	11	20	44	
Both Femora	None	None	1	1	
Upper Third	2	4	5	11	
Middle Third	16	14	29	59	
Lower Third	6	2	8	16	
Simple	24	20	40	84	
Compound	None	None	2 (Gunshot Wounds)	2	
Oblique	9	4	12	25	
Transverse	10	9	10	29	
Spiral	4	5	12	21	
Comminuted	1	2	8	11	
Alignment Good	4	14	40	58	
Alignment Fair	16	5	2	23	
Alignment Poor	4	1	None	5	
Position Good	4	8	36	48	
Position Fair	16	11	6	33	
Position Poor	4	1	None	5	
Union	24	20	42	Good in 86	
Shortening	In 10 femora, total 15 cm. Av. for 10 femora, 1.5 cm. Av. for 24 femora, .625 cm.	In 4 femora, total 4.4 cm. Av. for 4 femora, 1.1 cm. Av. for 20 femora, .22 cm.	In 4 femora, total 3.75 cm. Av. for 4 femora, .937 cm. Av. for 42 femora, .09 cm.		In 18 femora, total 23.15 cm. Av. in 18 femora, 1.29 cm. Gen. Av. in 86 femora, .269 cm.

Compensatory Lengthening	4—Total 4.9 cm.	2—Total 4 cm.	1—Total 3.5 cm.	7—Total 12.4 cm.	
	24	20	18	62	
Muscular Atrophy	Av. 2.5 plus	Av. 1.9 plus	Av. .9 plus		Av. 1.77 plus
Automobile Injuries	12	10	14	36	
Joint Complications	Knee 4—Hip 2	Knee 1—Hip 2	Knee 4—Hip 1	Knee 9—Hip 5	
Closed Reduction	24	20	42	86	
Mental Factor Good	14	16	36	66	
Mental Factor Fair	6	2	5	13	
Mental Factor Poor	4	2	None	6	
Anaesthetics	24—Ether	20—Ether	Novocain 39 Ether	2 Novocain 83 Ether	
No Displacement Upper Fragment	3	1	4	8	
Ant. Displacement Upper Fragment	6	7	10	23	
Post. Displacement Upper Fragment	2	1	7	10	
Ext. and Ant. Disp. Upper Fragment	10	6	10	26	
Int. and Ant. Disp. Upper Fragment	3	2	6	11	
Post. and Ext. Disp. Upper Fragment	0	2	4	6	
Post. and Int. Disp. Upper Fragment	0	1	1	2	
No Displacement Lower Fragment	3	1	4	8	
Ant. Displacement Lower Fragment	3	1	6	10	
Post. Displacement Lower Fragment	7	9	12	28	
Ext. and Ant. Disp. Lower Fragment	2	0	4	6	
Int. and Ant. Disp. Lower Fragment	2	2	2	6	
Post. and Ext. Disp. Lower Fragment	3	4	8	15	
Post. and Int. Disp. Lower Fragment	4	3	6	13	
Full Motion in Knee Obtained	65th Day	55th Day	33.77th Day		51.26th Day
Malposition Following Reduction	6 Cases—25%	2 Cases—8.33%	None	8	
Days When Walking after Fracture	69	63.3	49.4		60.57 Days

Av. for 24 femora, .625 cm. Av. for 20 femora, .22 cm. Av. for 42 femora, .09 cm. Gen. Av. in 86 femora, .269 cm.

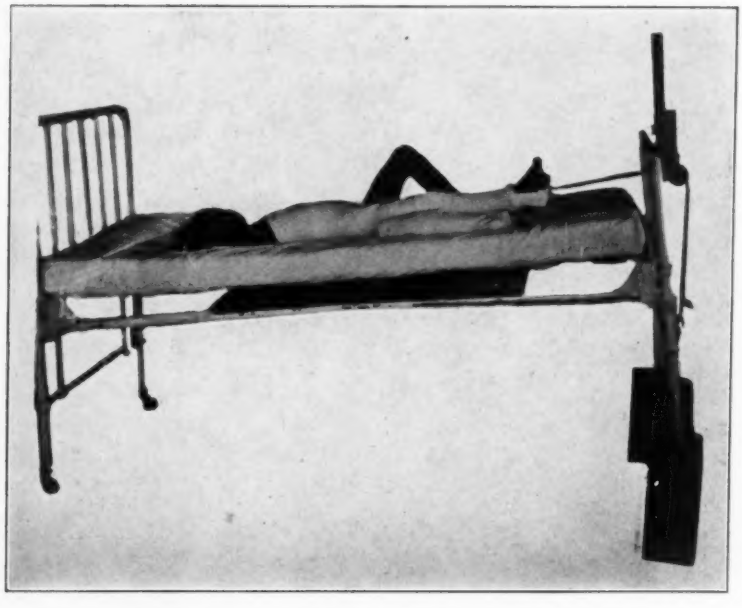

FIG. 2

Type of treatment used in Series *B*, plaster cast and extension; twenty cases. Following the reduction of the fracture, with the aid of the fluoroscope under ether anaesthetic, and with the thigh and leg abducted, a plaster spica was applied from the axillae to the lower third of the leg, after adhesive to the leg for Buck's extension had been applied. Patient was then returned to the ward and extension applied, the amount of weight being in proportion to the age and size of the child. Fracture boards were placed under the patient, and the foot of the bed was elevated.

These patients averaged 38.3 days in plaster and extension and 43 days in the hospital. (See Series *B*.)

According to ages they are classified as follows:

Age	0–1–2	3–4–5	6–7–8	9–10–11	Total
Series *A*	4	7	9	4	24
Series *B*	3	4	6	7	20
Series *C*	8	11	18	4	41

Of the ten cases of shortening in Series *A*, two of the patients were aged eleven years, three were aged eight years, two were aged seven years, one was aged five years, and two were three years of age. Of the four cases of compensatory lengthening in Series *A* two patients were three years of age, one was aged five years, and one was aged two years.

Of the four cases of shortening in Series *B*, one patient was aged nine years, two were aged seven years, and one was aged six years. Of the two cases of compensatory lengthening in Series *B* one was aged seven years and one was aged six years.

Of the four cases of shortening in Series *C* two were aged eleven years, one was aged ten years, and one aged eight years.

The one case of compensatory lengthening in Series *C* was in a patient eight years of age.

The following conclusions can be drawn from the foregoing presentation:

The older the child the more is the muscle pull and, therefore, the more traction must be exerted.

With plaster cast, better results are obtained in the very young, rather than in the older child. For example,—in Series *A*, where no traction was used at all, the greater number of shortenings were in the older children.

Pull can be overcome, good alignment, as well as good bone apposition, can be obtained where enough traction is exerted. Vertical traction was not as successful as the horizontal traction in the older child. The latter may be used alone or with the plaster spica, as in Series *B*.

Muscular atrophy is a great consideration in the treatment of fractures. In this series muscular atrophy was classified as one, two, three, and four plus.

One frequently sees rather disastrous results in joints and muscle wasting from the prolongation of the application of a plaster cast, which is absolutely avoidable and should never occur.

Where the leg is not confined in plaster and where radiant light can be applied to the muscles and adjoining joints, far less muscular atrophy, as well as less joint involvement, takes place.

In three cases in Series *A*, in spite of the very best of care, the patient suffered very severely following the application of the plaster cast, and the

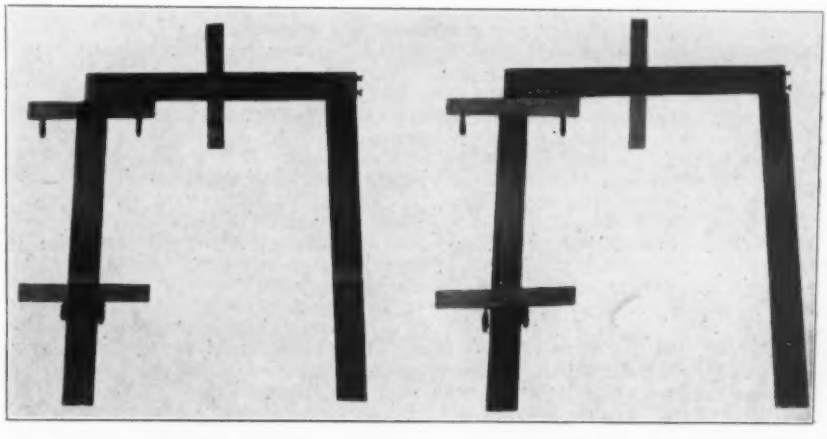

FIG. 3-A FIG. 3-B

Fig. 3-A and Fig. 3-B. Inside and outside views of the type of frame used in the treatment of the cases in Series *C*, where extension and suspension were used in 41 cases with 42 fractured femora (shaft). These cases averaged 25.8 days in extension and suspension and 7.37 days in extension (Buck's), and 46 days in the hospital. (See Series *C*.) Following the administration of an anaesthetic, traction was applied and proper reduction was carried out, with the aid of a fluoroscope. The weight attached was in proportion to age and size of child. The muslin retractor (Figs. 10 to 14-B inclusive) was also applied immediately following the above procedure. The operation was performed with the patient in the bed.

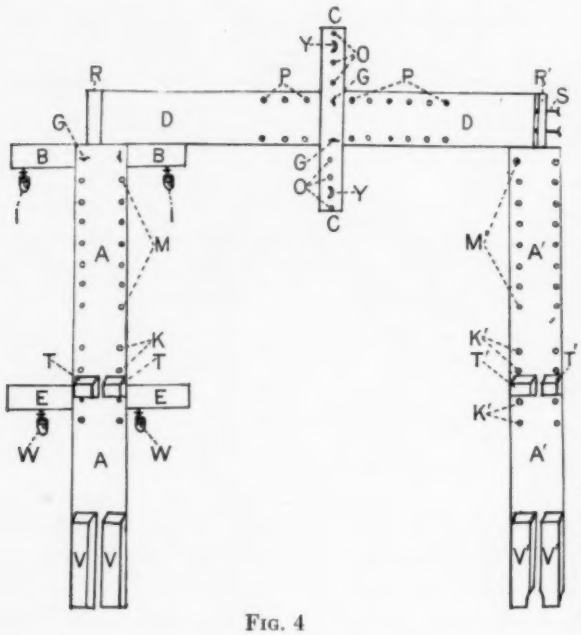

FIG. 4

FIG. 4

Inside of the frame. *A* shows the headboard and *A'* the footboard. These boards are 56 in. high × ¾ in. thick × 5½ in. wide.

Board *D* is the cross-piece leading from the head to the foot, and is 53½ in. × ¾ in. × 5½ in. These boards are made at such length and height as to fit into the standard child's hospital bed. For other types of bed, any variation of this can be made, if necessary, and can be as easily used in the home as in the hospital.

B is the cross-piece which is 25 in. long × 1½ in. thick × 2¼ in. wide. It holds the two ropes from the main extension, which come through the pulleys *Y-Y* on board *C*.

E is the same width as *B* and holds the pulleys for the ropes which run from the extension on each foot, these being applied to prevent any external rotation of the distal fragment, thereby preventing misalignment of the distal fragment and foot.

C is also the same width, thickness and length as *B* and *E*. It is the cross-piece where the first part of the extension is applied on pulleys *Y-Y*.

G shows the wing nut which is used on the bolts *S*, which hold the boards *D*, *A*, and *A'* and are easily adjusted and interchangeable. These bolts are ¼ in. × 4 in. and, as previously stated, are interchangeable at any point where they have to be used.

I-I show the pulleys where the second part of the extension is applied.

R-R' show blocks, which are 1 in. × 1½ in. × 5½ in., and are screwed on the board *D* with two holes for the bolts *S* to be applied. These bolts, with the wing nuts, go through the pieces *R* and *R'*, then through the holes *M* and *M'* on boards *A* and *A'*.

O shows holes bored into board *C* for pulleys *Y-Y*, so that as much adduction or abduction of thighs as is necessary can be obtained. Board *B* has holes along bottom also, corresponding to the holes *O* on board *C* for the pulleys *I-I*. To allow board *C* to be slipped along on board *D* according to the length of patient's body, holes *P-P* are made.

S shows the view of the bolts ¼ in. × 2 in. long and the wing nut. These bolts go through block *R-R'* and upper end of *A* and A' through holes *M-M'*.

M-M' are a series of holes which are made 3 in. apart in breadth and height in boards *A-A'*. They correspond exactly on each board, in order to allow board *D* to be adjusted up and down according to the height of the patient.

K-K' show series of holes which are bored 3 in. apart in width and height in boards *A-A'*, which allow board *E* to be moved up and down to correspond with the amount of dorsiflexion, which is desired on the feet. These holes, *K-K'*, are also used, as well as board *E*, for Buck's extension in later stage of convalescent period (Fig. 22).

W-W are pulleys which hold the ropes from the extension on the feet; also for the Buck's extension (See Figure 22). On the under surface of board *E* are holes for the reception of pulleys *W-W* to allow for the necessary amount of abduction or adduction of the thigh when Buck's extension is used, or to allow as much inward rotation of legs as is necessary.

T-T' are blocks 1 in. × 1½ in. × 2¼ in. and are used to steady the frame on the rods of the bed (head and foot). These blocks are held on boards by screws *A-A'*. *V* and *V'* are blocks 7 in. long × 1½ in. × 2½ in. These are also used to steady the frame on the bed, at the head and foot.

These frames can easily have their dimensions changed to conform to a larger bed if necessary.

FIG. 5

Outside of the frame. In addition to previous explanations we have shown here *J* and *J'* on boards *A* and *A'*; *J* and *J'* on board *D*; *F* and *F'* on boards *A* and *A'*. *J*-*J'* are screws, 1½ in. (size 10), which are used to hold blocks *T* and *T'*, and *R* and *R'* and *V* and *V'*. No nails are used in the frame, and the parts are held in place by the screws, and the carriage bolts ¼ in. by 4 in., with the wing nuts. Pulleys *W* and *W* and *I* and *I* are sizes ¼ in. with a 2½ in. roller.

Bolts *H* are used to assemble the frame. The wing nuts *G* are used on these bolts.

The bolts and nuts are used on *D*, *A*-*A'*, *B*, *E*, *C*.

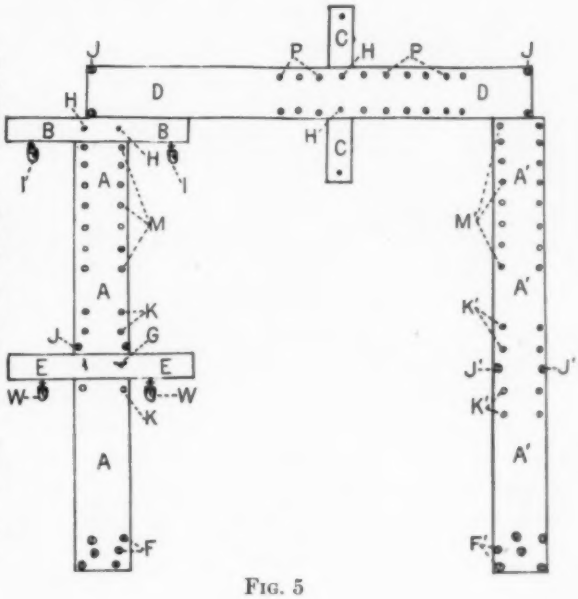

FIG. 5

plaster spica had to be removed and reapplied. With the suspension and extension method, frequent daily inspections could be carried out and radiographs could be made whenever desired, as the patient could be removed to the x-ray department or the portable x-ray machine could be carried to the patient.

In Series *C* there was no joint complication whatever that was due to the suspension and extension methods. The joint complications in Series *C* were due to the fact that the fracture either involved the articular surfaces of the joints, or the soft structures were severely involved.

The mental factor is presented in this series of cases because it is a thing to be considered as much in the child as in the adult. If the form of treatment is satisfactory and the patient is comfortable, with the cooperation of the patient better results are obtainable. In no case of Series *C* did the patient complain of any special pain after twenty-four hours following reduction. There were only a few complaints of pain in Series *B*, and these complaints were instantly relieved by the application of more traction. In the majority of cases, where the patient was comfortable, good position of the broken fragments and good alignment of the limb usually were present.

Sixty per cent. of these cases had marked soft structure injuries, especially the thirty-six cases of the automobile injuries.

In ten cases union was slow. Five of these ten cases were in Series *A*. In no case was non-union present. When there was any suggestion of delayed callus formation, rigid dietetic treatment was carried out, such as

cod-liver oil and vegetables, and a general treatment of actinic, starting with a dosage of four minutes per day, increasing dosage up to forty minutes per day.

The two cases for which local anaesthetic (novocain) was used with success, were cases where general anaesthetic was contraindicated. In both cases there were severe chest injuries. The local anaesthetic was infiltrated around the thigh above the fracture and reduction of the fracture was accomplished without any pain or untoward shock.

Seventy cases were seen within twelve hours following injury; nine cases were seen within twenty-four hours; and the remaining six cases were seen within thirty-six hours following injury. Each case was treated as an emergency, on admission to the hospital, day or night. In cases where there was severe shock, delay was necessitated until the general physical condition permitted reduction. There was no death.

More left femora were broken than right, probably because in the young patient sufficient defensive power has not been developed, as in the

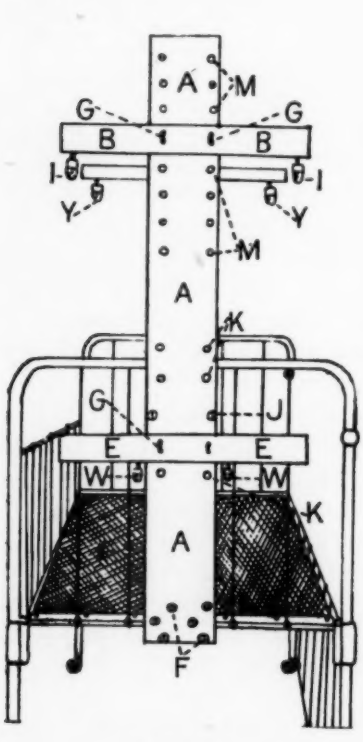

FIG. 6-A

Diagram of the outside of the head of frame applied to the bed.

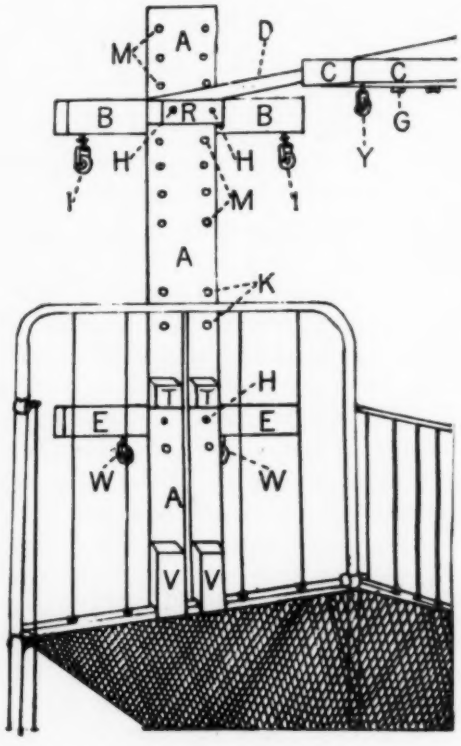

FIG. 6-B

Diagram of the inside of the head of the frame applied to the bed.

Note how blocks *T-T* and *V-V* fit on each side of the middle rod on the head of the bed. Small notch is also made in each block *V*. These notches fit over the bottom rod on the head and foot of the bed.

adult. In the latter, statistics show that there are more right femora fractured.

It is interesting also to note that the middle third predominates, and that there are more transverse fractures than other types.

The Bradford frame, with the writer's frame and retractor, was used in three cases in Series *C* without any definite improvement. By this combined treatment no greater traction or more comfort for the patient was experienced than by the use of the writer's frame and retractor with patient on the bed, as in Figures 19 to 21-B inclusive.

Alignment was always considered first, position second. It has been stated that enough traction of the fractured femora cannot be applied to pull down the fragments, where both legs are in the vertical position. This is because proper countertraction was not made. In no case in Series *C* was there a failure to secure as much traction as necessary, where the muslin retractor was used, as in Figures 10 to 15-B and Figures 17-A and 17-B and Figures 19 to 21-B.

In four cases in Series *C* there was a tendency for the fragments to overlap, and by the application of more weight full traction and easy approximation of fragments were accomplished.

Extension can be kept on too long. It is as important to remove it as early as possible as it is to use it, because if it is kept on too long, the muscles do not respond as early as they should. To relieve the prolonged

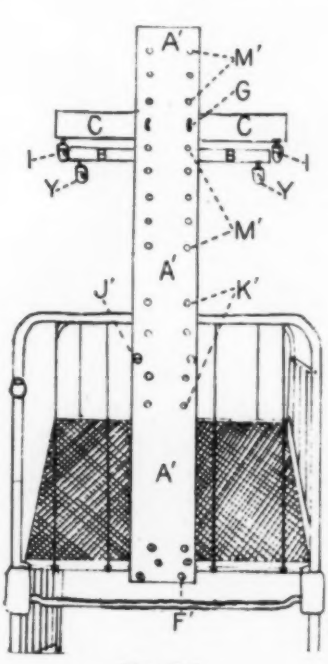

FIG. 7-A

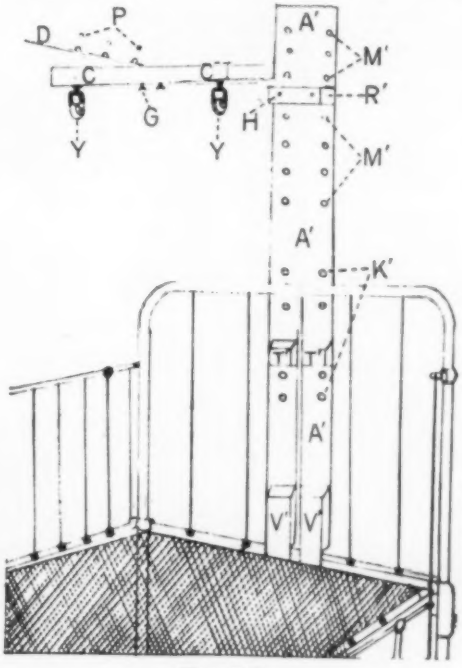

FIG. 7-B

Fig. 7-A and Fig. 7-B. Diagrams of the outside and inside of the foot of the frame attached to the bed.

suspension the use of Buck's extension was found very efficacious, as in Figure 22. Here it is used following the removal of the limb from suspension; and active and passive motion, and hot baths are commenced, with the continuance of radiant light applications.

In very few cases in Series *B* and Series *C* was the adhesive troublesome or did any complications occur. Great care was taken to prevent any pressure on the condyles of the femur or malleoli, these places being well padded.

In the treatment by suspension and extension method, there has been an objection raised that the cross-bar in the average overhead extension frame is not high enough, and even in those frames where the cross-piece is high enough the patient's leg slips up to the cross-piece. It is reasonable to presume that in these cases traction would also be of no use whatever, unless countertraction was used.

The frequent objection to the patient's remaining in bed, as in Series *B* and *C*, seems to the writer to be of no consequence. In no case was there a pneumonia complication and in no case was there any serious complication from the bed treatment. It is very easy to roll the patient's bed about to any place desired without any handicap to the patient or any serious interference with the fractured limb, when the suspension and extension method is used.

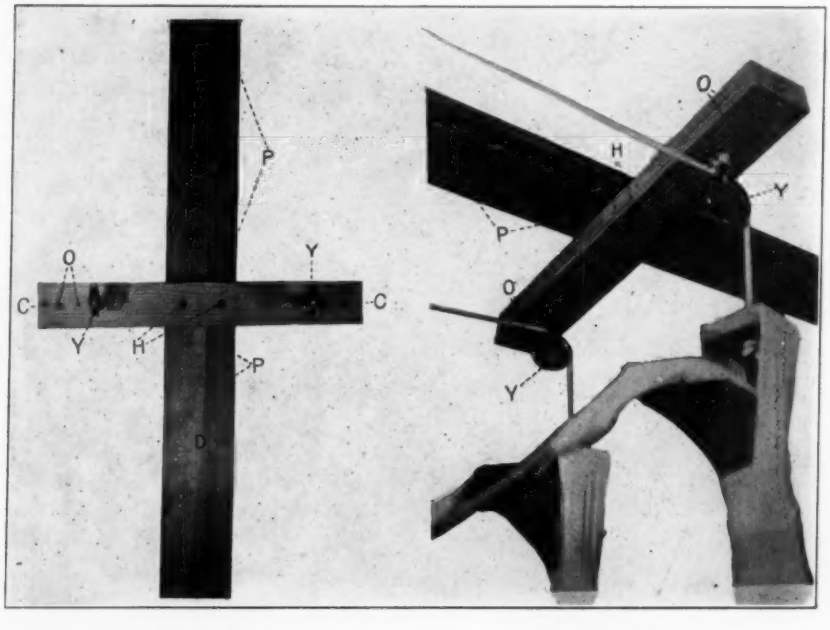

FIG. 8-A FIG. 8-B

Fig. 8-A. Close-up view of board *D*, where the main pull is applied through pulleys *Y-Y* on cross-piece *C*.

Fig. 8-B. Close-up view of the extension on board *D*, at pulleys *Y-Y* on cross-piece *C*. It also shows application of adhesive on soles of feet for the prevention of any external rotation of the distal fragment.

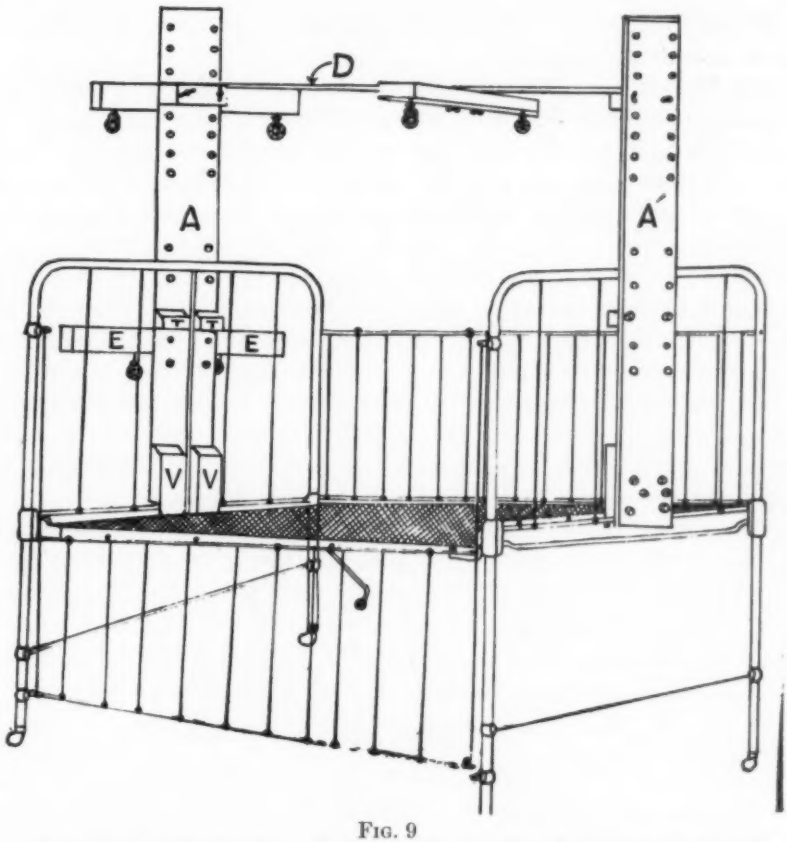

FIG. 9

Diagram of the frame applied to the bed. Note that the frame is stabilized on the bed by the blocks *T-T* and *V-V* and also by the cross-piece *D*, which is attached to the headboard *A* and footboard *A'*.

The suspension and extension methods can be carried out at home as well as in the hospital. Another great advantage of the suspension method is the easy access for changing of the bed linen, frequent inspections, and use of the roentgen ray.

No open reduction was necessary. No walking caliper was used, because it prevented the free and constant motion of the knee and the full use of the muscles. It failed to enable the patient to carry out his coordinative power as in active motion. It is true that the patient does take chances without a walking caliper, but by the active and passive motion of his limb the muscular development and callus formation was faster.

Weight-bearing in any form was never allowed until it was definitely settled that the patient had enough callus formation to prevent any misalignment. In only two cases did any misalignment occur, which was corrected immediately with good results.

The days listed as "when walking" denote when the patient discarded crutches. The older the patient, of course, the longer the use of crutches.

No skeletal traction was found necessary in any case, and its use is seldom indicated in the child.

The Wassermann test was made in every case. It was taken within a few moments or hours following injury. The earlier the Wassermann was taken following injury, the larger the per cent. of positive reactions. Every positive Wassermann was checked ten to fourteen days following injury and out of nine original positive Wassermanns the check showed seven negatives[3].

From the review of the surgical literature there is no doubt but that compensatory lengthening does occur; it did occur in the writer's series also. However, it is the writer's opinion that one should not rely too much upon the future, hoping that the results of one's mistakes will be improved upon by compensatory lengthening. If the cases are properly handled few, if any, cases of shortening should occur. As previously stated, such a handicap to the child, even though full compensatory lengthening does eventually take place, is a very grave injustice to the child.

The general impression that, regardless of the method of treatment of fractures of the femur in children, good results will be obtained is wrong. In no instance of any fracture in the body is it so important that proper treatment be given as in the fractured femur of the child. A good limb in a child is more important than in the adult. Its psychic effect is very important and a disability works grave hardships on the youngster.

TREATMENT

The technique in Series *A* is as follows:

On admission to the dressing room, the nature of the fracture, deformity, and shortening are recorded. A towel is placed around the ankle in

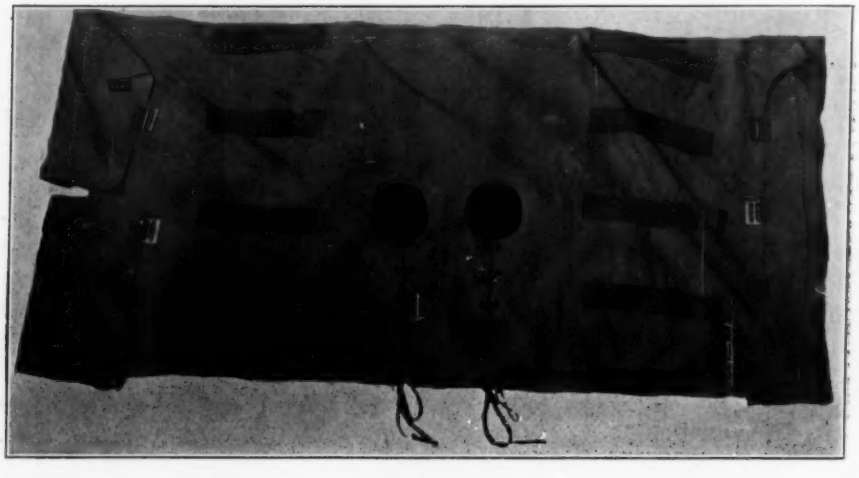

FIG. 10

Muslin retractor, which is applied to patient and to the bed, to prevent the patient from moving about in bed, and also to make countertraction against the main pull on the thighs.

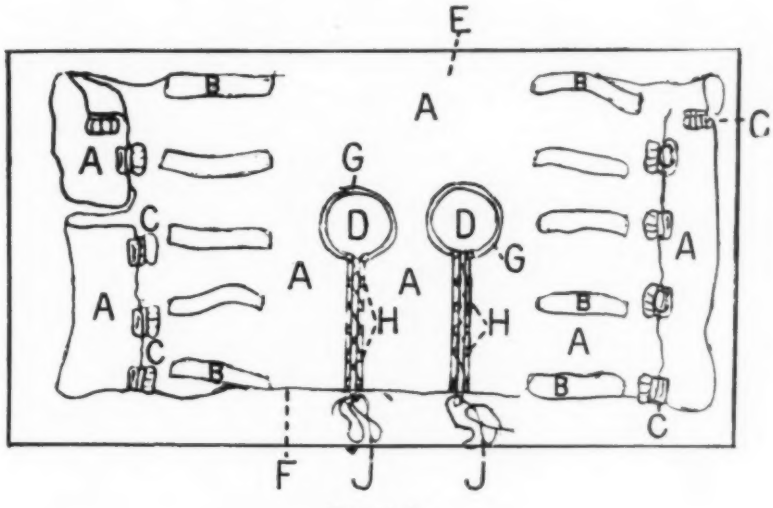

FIG. 11-A

Diagram of the muslin retractor.

A shows the main part of the retractor, which is 66 in. long by 24 in. wide.

B shows the muslin strips which are sewed on the main part of the retractor. They are 8 in. long and are usually placed about 2 in. to 3 in. apart, and average 5 in. to 6 in. on each end of the retractor. They are placed about 20 in. from attachment of buckles *C*.

These buckles, *C*, correspond in number to the strips *B*. They are 1½ in. wide and are sewed on the back part of each end of the retractor. It will be seen here that the ends are folded over and show the buckles sewed on the back.

D shows spaces for the thighs, with a separation of usually about 3 in. between the two openings. These openings range about 4 in. to 5 in. in diameter. If the leg is larger than these holes—*D*—it will not be very difficult to start lacing the laces *J* one or more eyelets lower, so that the circumference of the holes *D* will be much larger.

G shows heavy stitching around the openings to prevent any ripping of the cloth.

H shows eyelets, which are usually about 1 in. apart. These are for the lacings *J-J*.

E shows the upper edge and *F* shows the lower edge of the retractor.

the form of a loop and a rope is attached, from which traction of eight to twelve pounds at most is immediately made over the foot of the stretcher. This procedure relieves the patient of considerable pain caused by the fragments pressing against the soft structures, overcomes muscular spasm, prevents further overriding, and facilitates subsequent reduction. All fractures of the femur are treated as emergency cases and the senior member of the Fracture Service is required to be present. History of the patient's injury is secured and thorough examination of the patient is made at the same time. Great gentleness and care are observed in the physical examination and all unnecessary movements are prevented. Radiographs are taken and studied carefully. If general condition permits, a general anaesthetic is then administered. All measures for the care of any wound, in case of laceration or compound fracture, are employed. Patient is placed on traction table and reduction is carried out under fluoroscope. Thigh

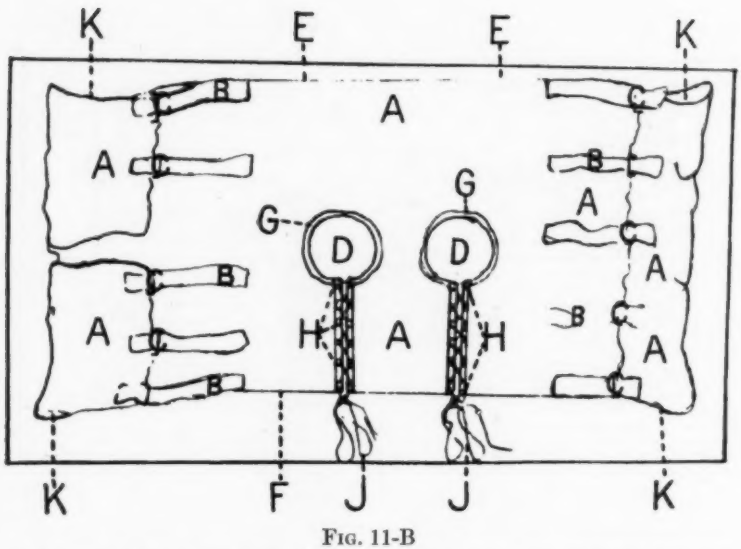

FIG. 11-B

Diagram of the strips *B* and buckles *C* buckled together, showing how any amount of tension can be had on the patient by tightening the buckles and straps.

K-K shows the overlapping of each of the retractor ends—where it goes underneath the railings on each side of the bed.

The slit on the left side of the retractor is made in order to go around the footboard on the child's hospital bed. This slit is 9 in. long.

and leg are placed at twenty-five degrees of abduction at hip, and plaster cast is applied from axillae to the base of the toes. Patient is then placed in the bed. Fracture board splints are applied on the bed underneath patient (Fig. 1). Frequent radiographs are taken to check up any misalignment or poor position. Patient is observed for an average of twenty days, then is sent home with instructions to report at frequent intervals at the Out-patient Clinic. After an average of forty-one and sixty-nine one-hundredths days, the plaster cast is removed. Following the removal of plaster cast, different forms of physiotherapy, — radiant light, diathermy, hot baths, active and passive motion — are used. Patient is allowed crutches, with no weight-bearing until after an average of fifty days.

During the period of convalescence rigid instructions are given to use active and passive motion. Frequent visits are made to Out-patient Department until patient is entirely well. No weight-bearing is allowed until good callus formation is present.

In Series *B* the same routine of treatment is carried out on admission as in Series *A*, excepting that, previous to the reduction of the fractured femur under anaesthetic, adhesive is applied on each side of the involved leg, from below the knee down to the wooden block for Buck's extension. Plaster spica is then applied with the thigh in twenty-five degrees of abduction at the hip. The spica extends from the axillae to the lower third of leg. Fluoroscope is used while the reduction is being made and patient is

then taken to the ward and traction is applied (Fig. 2). Fracture boards are applied on the bed underneath patient. Continuous traction is kept up on an average of thirty-four days. Usually the plaster is removed from just above the knee down to the lower third of leg on an average of from twenty-one to twenty-three days following reduction. Radiant light and gradual active and passive motion are commenced. The cast is removed in an average of thirty-eight and three-tenths days. Patient remains in the hospital on an average of forty-three days. Routine treatment is given following removal of plaster spica, as in the treatment of Series *A*.

A careful check with radiograph is frequently made during period in hospital and Out-patient clinic observation. Frequent visits are made to Out-patient Department until patient is entirely well. No weight-bearing is allowed until good callus formation is present.

In Series *C* careful examination, physical and radiologic, is made as previously stated in Series *A* and Series *B*. The patient is given anaesthetic, either in ward, operating room, or in the x-ray room, and reduction is carried out under the fluoroscope with patient in bed, after both legs have been suspended and extended in writer's frame, with the traction and countertraction applied as in Figures 19 to 21-B inclusive. The amount of weight applied in this series, as well as in Series *B*, depends always, of

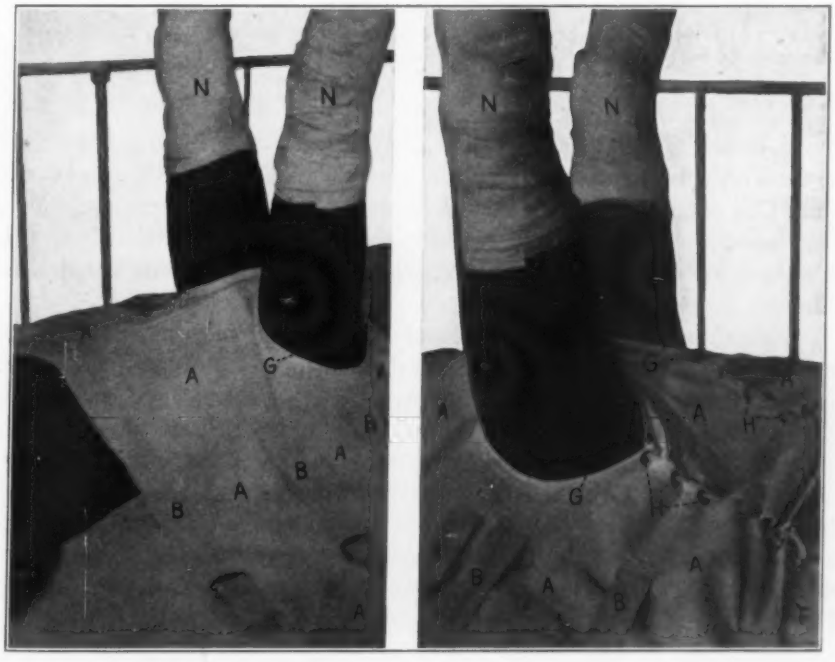

FIG. 12-A FIG. 12-B

Fig. 12-A and Fig. 12-B—Close-up photographs of the patient in the retractor. *N* shows the application of the traction (adhesive) which is applied from the point immediately below the fractured femur to the wooden blocks beyond the soles of the feet.

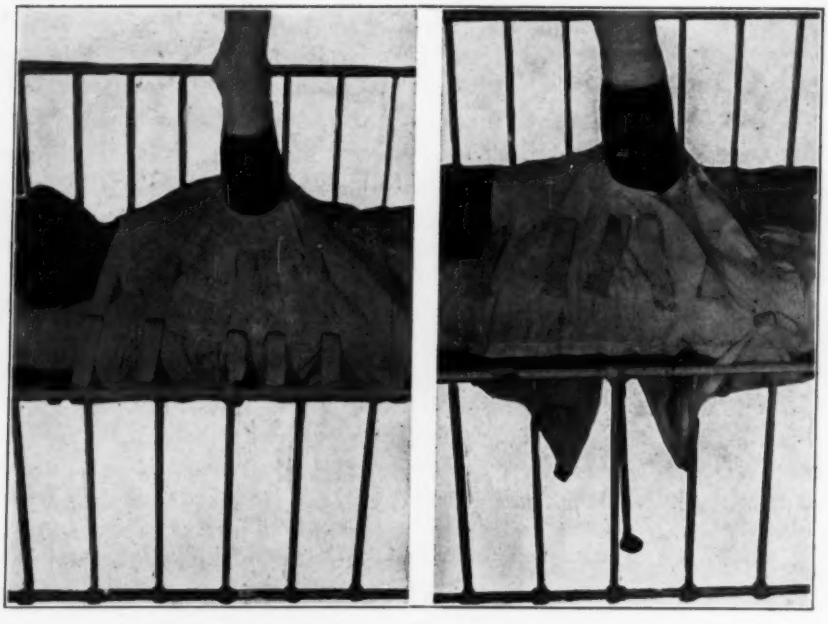

FIG. 13-A FIG. 13-B

Fig. 13-A—Retractor in place with side of bed lowered.
Fig. 13-B—Retractor unbuckled. Note the slit in the retractor, which goes around the foot-board on the child's bed. This slit is 9 in. long.

course, on the size and age of patient. After the average amount of weight for the average case has been applied—weights, ranging from ten to twenty pounds on each extremity—a check with the fluoroscope is made, and, if there is not proper reduction, more weight is applied. As previously stated, in no case in Series *C* did we fail to obtain as much traction as was desired following these reductions.

Patient remains in suspension and extension for an average of twenty-five and eight-tenths days. Frequent daily inspections of limbs are made. Radiant light is used daily. Frequent checks with x-ray are made. The suspension is removed without an anaesthetic and Buck's extension is applied, as in Figure 22, for an average of seven or eight days. Diathermy, radiant light, etc., are then commenced with active and passive motion. Patient is discharged on crutches. Frequent radiographic examinations are made during the entire period of patient's convalescence. Close observation is carried out in the Out-patient Department. Patient is not allowed to bear weight until callus formation is sufficient to prevent any misalignment.

In every case in the three series the mental attitude of the patient is considered as much as the fractured femur. At no time is the patient considered a mechanical toy; and the writer definitely concludes that the mental factor between doctor and patient is a great asset to final results. This

cannot be successfully accomplished unless the patient is seen frequently and is kept constantly under the personal supervision of one individual during the entire period of convalescence of the patient.

Review of the Different Methods of Treatment and Results Attained by the Following Surgeons in Acute Fractures of the Shaft of the Femur in Children

W. H. COLE

W. H. Cole[4] reports the results of treatment of fractures of the shaft of the femur in children with special reference to Bryant's overhead traction (35 cases). Cole favors the overhead suspension in oblique fractures and plaster casts in the transverse fractures. He recommends that only one leg be suspended, stating that the countertraction of the body is not sufficient weight against the distal fragment, thereby providing enough extension of the limb. He applies plaster cast to the entire leg and hip, after removing the limb from suspension at the end of an average of three and a half to four weeks, leaving the cast on for an average of two and a half to three weeks. Cole states that, even though this method of suspension in its various forms has been in common use for the past thirty or forty years, very little mention is made of it in the literature. He divides his different forms of treatment as follows:

1. Overhead traction
2. Plaster cast
3. Splints
4. Horizontal traction
5. Open reduction
6. Modified Steinmann pin

Types of fractures were classified as follows:

Transverse	15
Oblique	15
Green stick	1
Pathological	4

Five of the transverse fractures were treated by plaster casts. No displacement occurred in any one of the five cases. Eighteen of the thirty-one cases were treated by overhead extension. Most of the oblique fractures were treated by overhead traction. This method, however, was used in some of the transverse fractures. In all of the transverse fractures there was overriding. Three of the transverse fractures were treated by open reduction. Ages ranged from one to twelve years. Thirty-one cases were simple fractures and four were pathologic fractures.

Cole states that one of the greatest achievements of overhead traction is the simplicity of the traction and the relatively slight tension required. On account of the decreasing flaccidity of the hip joint with age, the use of overhead traction was restricted roughly to patients below the age of ten

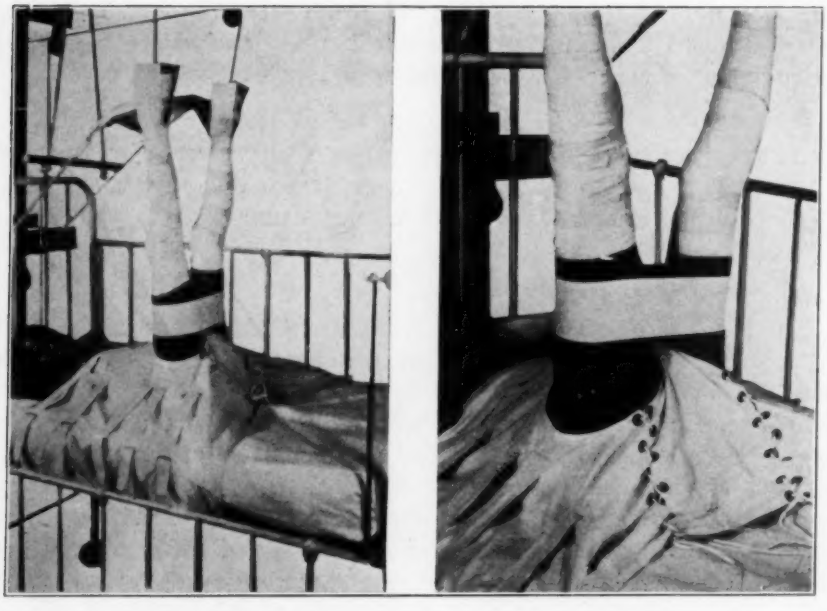

FIG. 14-A FIG. 14-B

Fig. 14-A and Fig. 14-B. Close-up views of the retractor, showing application of adhesive around the thighs, which is used sometimes where there is too much external displacement of either proximal or distal fragments. This procedure was very successful for improving the alignment in a number of cases. It is necessary to use this only during the first few days, because after a few days of prolonged traction the fragments remain in position without difficulty and, with the rapid formation of callus, this aids also in keeping the fragments in alignment.

years. A decided advantage in treating fractures in infants by this method, according to Cole, is the cleanliness and immediate relief from discomfort that it affords. Cole cites the fact that it is almost impossible to get a form of splint or cast which, when applied to a patient under the age of ten, can be kept free from urine and feces; and when children are put up in splints they invariably cry and fret for many days following the fracture. He did not have a single patient who did not cease to fret within twelve hours after the application of overhead traction.

It is also Cole's idea that various methods of operative reductions—such as the use of ice tongs, open reduction, steel pins, plates, and metal rings—can be used, but certainly they are indicated in a relatively small percentage of cases.

According to Cole, one of the most striking observations is the absence of shortening seen in cases which healed with fragments distinctly in an overriding position. Moreover, when the patient returns a few years later, the affected extremity shows no shortening. Repeated roentgenograms for a few weeks and a few years after treatment reveal no separation of the femur from the tibia, due to stretching of the ligaments about the knee joint. The question arises as to the location of the compensation. The ligaments of the ankle are not included in the traction. Fundamentally

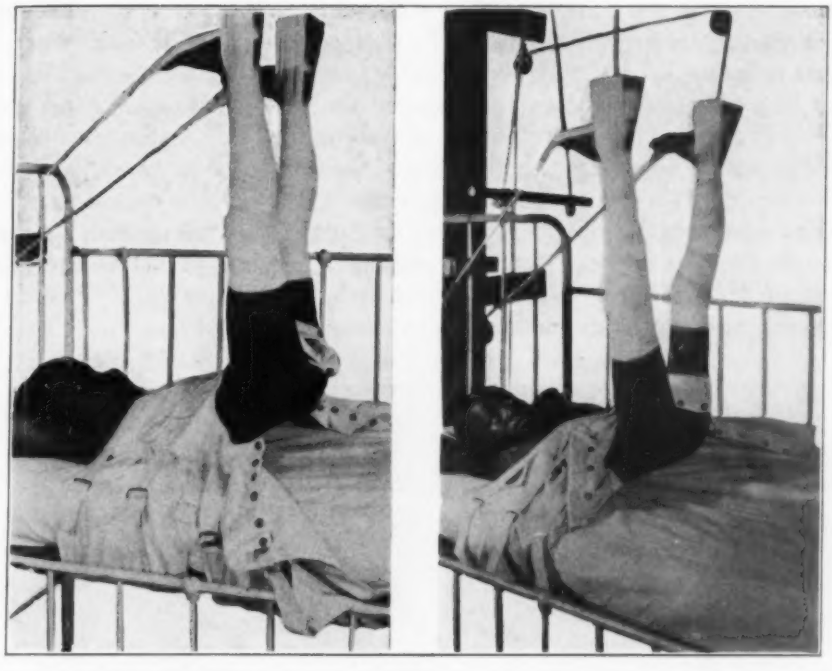

FIG. 15-A FIG. 15-B

Fig. 15-A and Fig. 15-B. Views showing the ease of removal of the lower part of the muslin retractor for patient to use bedpan or any other necessary toilet. Also note that the traction across patient's lower abdomen is still in place.

one cannot conceive of the hip joint allowing very much room for lengthening of the extremity. Apparently the only explanation remaining is that young bone yields to the constant pull and thus makes up the few centimeters of shortening necessary for compensation.

DAVID SILVER

Silver[5] has suggested the modification of the Bryant frame by attaching a vertical bar to the Bradford frame, and recommends overhead suspension and extension in certain types of fractures of the shaft of the femur in children.

Silver's apparatus is made as follows:

The gas-pipe frame is made in the usual way (about four inches longer than the patient and a little less in width than the distance between the shoulders). Opposite the hip joint of the fractured leg a T connection is placed; this must be screwed tightly, or riveted, to prevent turning. A cotter-pin is used, in order that the T connection may be turned and so adapt the frame either to a right or a left fracture. Into the T is screwed an upright piece of pipe, long enough to reach about four inches above the suspended foot. An L connection and a short (two to three inch) transverse piece of pipe, ending in a cap, completes the attachment. A single piece of canvas is used for the covering, a hole being made in the side for the upright to pass through. When it is desired to suspend both legs, the portion of the

frame on which the legs ordinarily rest may be made much shorter, merely long enough to prevent the frame from tipping; and the transverse pipe must be longer.

The patient is fixed on the frame in the customary manner and the adhesive straps, used for extension, are simply fastened to the transverse pipe at such a height that the buttock of the affected side swings clear, or both legs may be so suspended, if preferred. Carrying the napkin around the upright fixes the hips more firmly; if greater security is desired, a piece of adhesive plaster may be passed around the groin and fastened to the base of the upright. With coaptation splints, this gives a very secure dressing, the upright acting as a protection against injury.

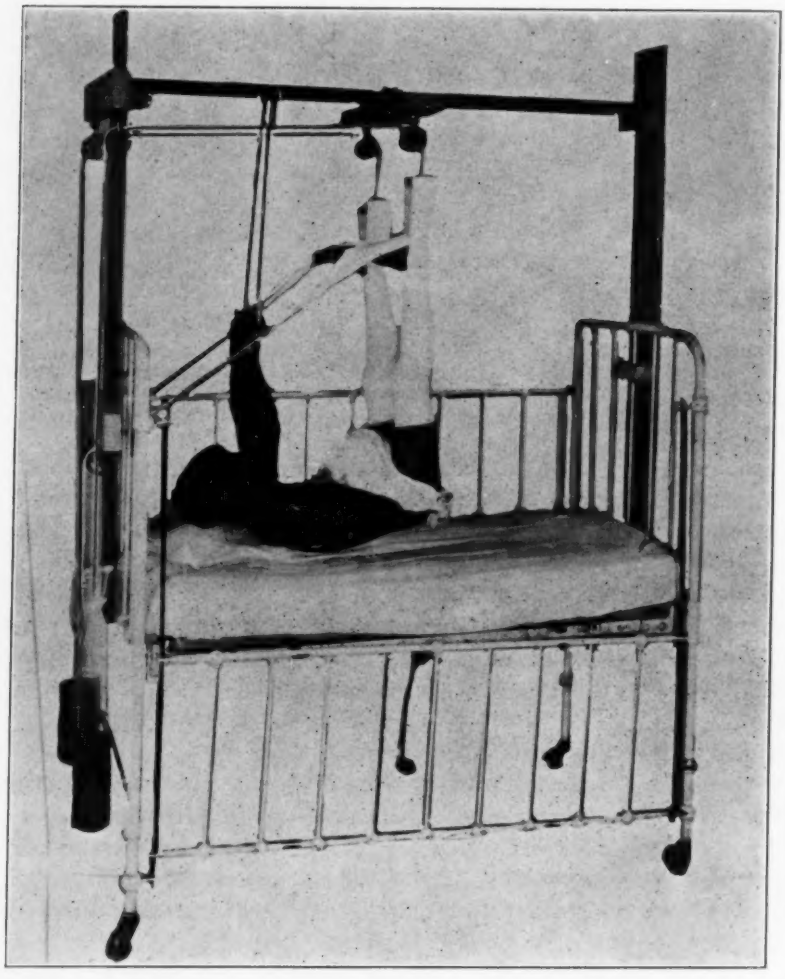

FIG. 16

View showing swing which enables patient to pull himself up so that bed clothes may be changed when necessary, or for any other necessary nursing.

KELLOGG SPEED

Kellogg Speed[6], in an analysis of results of treatment of fractures of the femoral diaphysis in children under twelve years of age, reports sixty-seven cases,—fourteen of them under two years old; twenty-five, two to six years old; thirty, six to eleven years of age.

Speed reports: operations for various fractures of the femoral shaft in children should be avoided; immediate treatment should be given; every hour of delay diminishes the possibility of perfect reduction; plaster casts are inadequate to maintain extension and alignment of the fractures; the most adequate method of holding the reduction, after it has been obtained, is continuous suspension traction by means of suspension splint and overhead frame; walking should not be allowed until a walking caliper splint is fitted to the patient.

Most of Speed's cases were reduced on a fracture table under anaesthetic, by mechanical traction. In cases where a complete reduction cannot be obtained, he states that the surgeon must be satisfied with the best reduction possible, provided it will result in good function; otherwise he should perform an open operation. He recommends daily application of physiotherapy, in the form of radiant light, massage, etc. He also uses a Thomas splint with the leg in more of a horizontal than perpendicular position.

RENÉ BLOCH

René Bloch[7] reports a series of fractures of the thigh in children. Fracture of the femur is more common in boys than in girls,—410 to 129. Bilateral fracture was found in only six cases out of 537; left femur 299 times to 240 on the right.

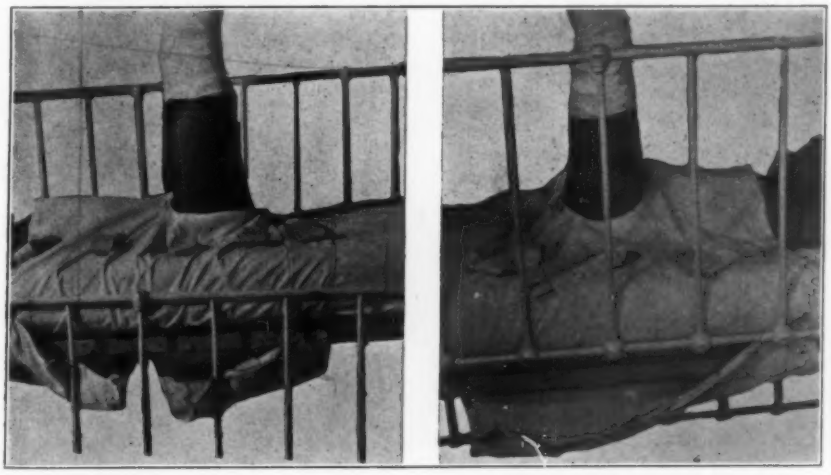

FIG. 17-A FIG. 17-B

Fig. 17-A. Shows how the right side of the muslin retractor is applied around the right railing of the bed.

Fig. 17-B. Shows how the left side of the muslin retractor is applied around the left side of the railing of the bed.

The mechanism may be direct violence, bending, jamming, or torsion. Direct violence, usually from running against an obstacle or being run over by a vehicle, is a frequent cause. Flexion fractures are produced by a fall on the knee or foot, which bends the thigh forward, breaking the femur. Longitudinal jamming of the bone may produce a rather rare telescoping fracture. Torsion fractures are oblique and are the most common. The usual mechanism is a fall with leg turned outward, (sometimes inward) the weight of the body twisting the femur, the lower end of which is fixed by the position of the leg on the ground.

Formation of callus is much more rapid in children than in adults. Good immobilization makes for good development of the callus. It will

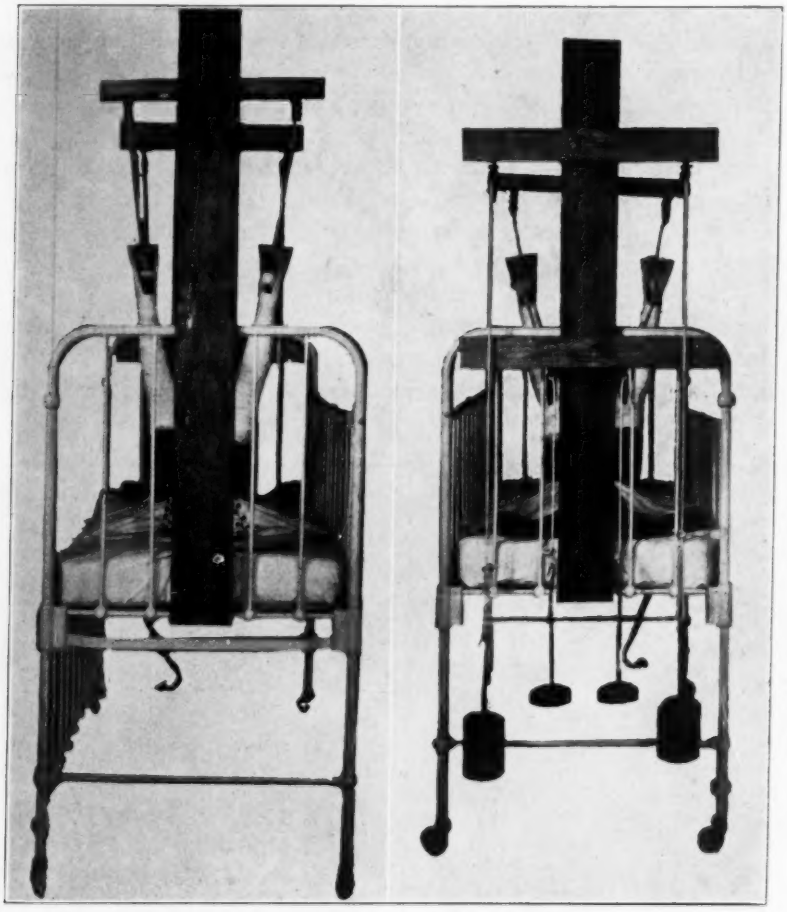

FIG. 18-A FIG. 18-B

Fig. 18-A and Fig. 18-B. Photographs of the patient in bed, showing the foot of the bed (Fig. 18-A), and the head of the bed (Fig. 18-B). Note that the weights are at the head of the bed, thereby causing all weights to be away from the aisle in the hospital, where they would easily be knocked off or be in the way.

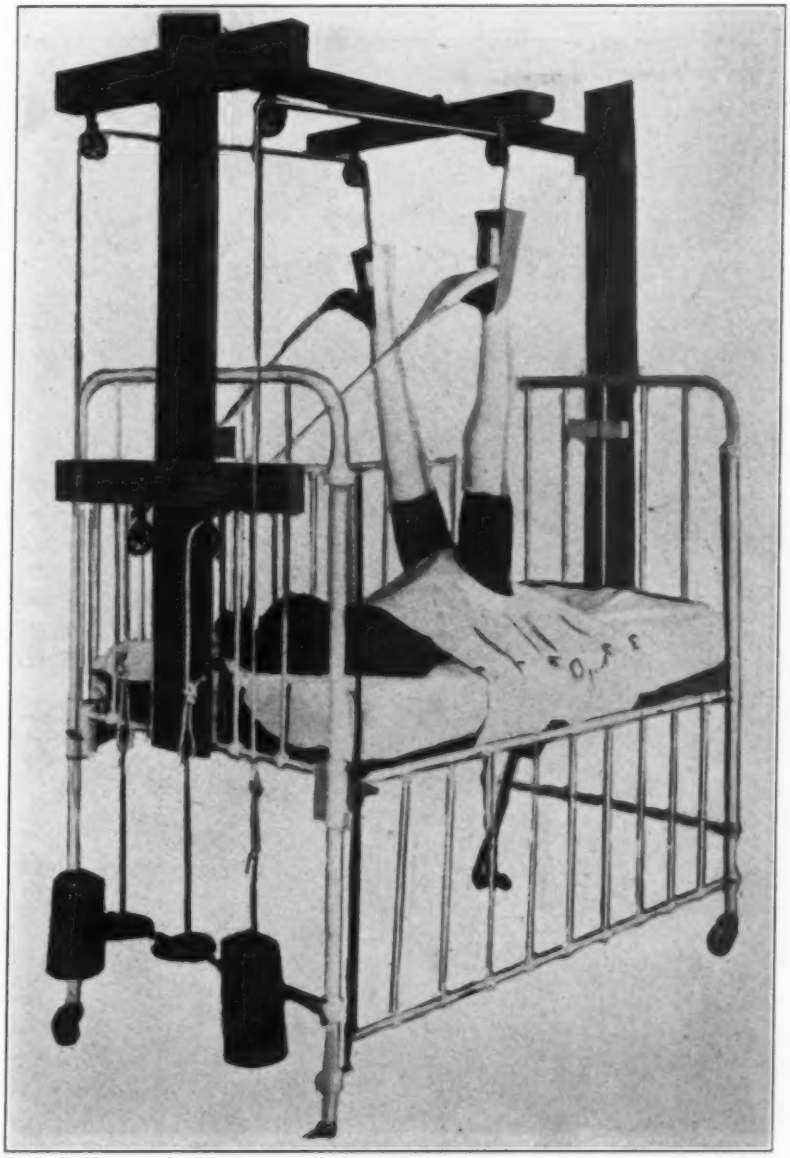

FIG. 19

Photograph of patient in bed, with overhead frame, traction and counter-traction applied. Radiant light, or any other treatment, can easily be applied daily to thighs; and frequent examination, physical and radiographic, can also be made without interfering with position of fragment, or causing patient any inconvenience.

FIG. 20

Photograph of patient in bed with overhead frame, traction and counter-traction applied. Note that the cross-piece *D* is lowered considerably to accommodate the length of the patient's legs.

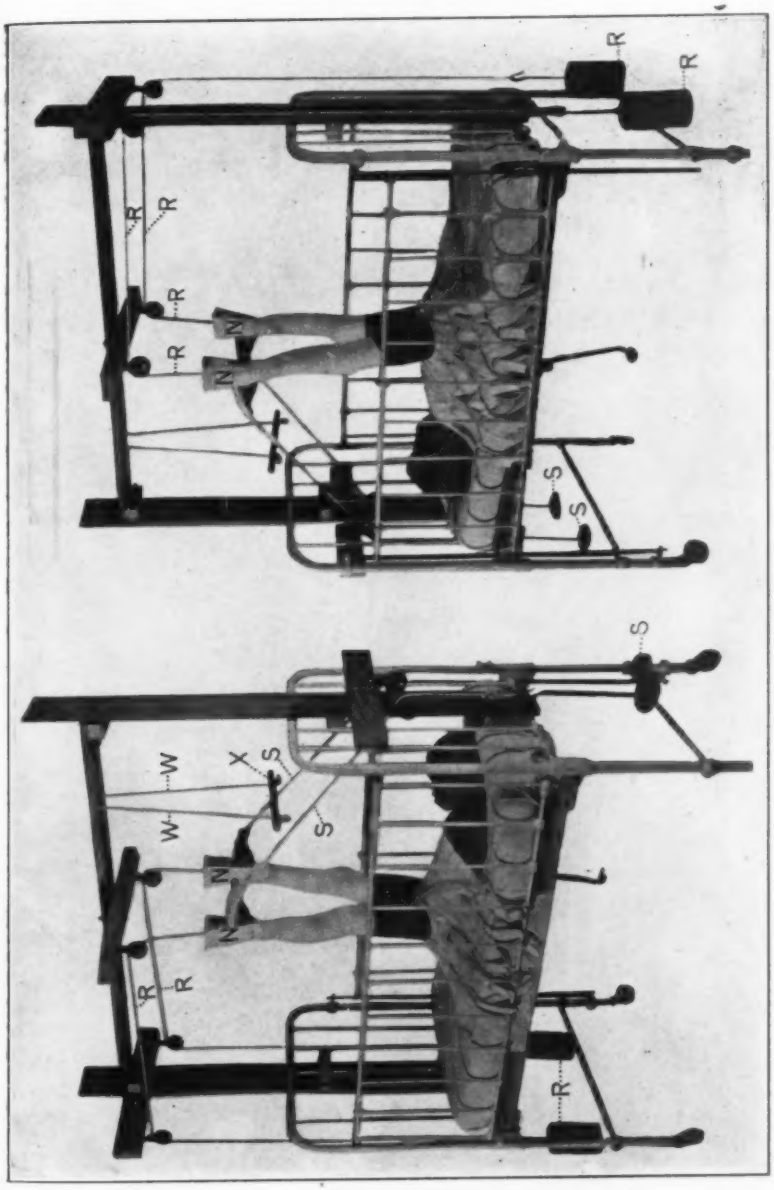

FIG. 21-A

FIG. 21-B

Fig. 21-A and Fig. 21-B. Photographs showing the ease with which the frame can be adjusted; where, if desired, the main traction can be placed at the foot of bed and the traction on soles of feet remain at the head of frame. This is not often necessary, and is not as desirable as when the weights (*R-R*) are at the head of the bed.

form without immobilization, but it becomes excessive and may interfere with function.

The prognosis of these fractures in children is excellent. Union takes place in about a month. There remains very slight, if any, shortening; or the broken femur may even be a trifle longer than the sound one, if rachitic curve is present. Late results are equally good. A femur, which may have had slight bowing deformity, becomes in a few years as straight as the good femur; and excess callus disappears.

Simple extension is the best method of treatment. The vertical extension commonly used in America is deemed unnecessary.

W. A. CLARK

William A. Clark[8] reports a series of thirty-one cases of acute fracture of the shaft of the femur—twenty boys and eleven girls. Fourteen of these cases were caused by automobile accidents. The majority of the fractures

FIG. 22

Buck's extension, which is applied after the patient has been taken out of the overhead suspension and extension. Treatment in Buck's extension averaged 7.37 days. During the whole period in Buck's extension, active and passive motion is carried out at frequent intervals during the day, with radiant light twice a day.

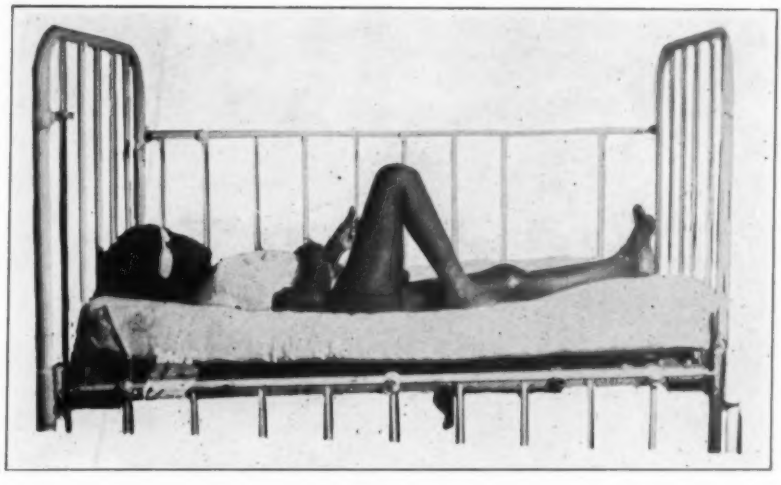

FIG. 23

Photograph showing amount of flexion of knee which is present in the average case following removal of leg from suspension and extension.

were in the middle third. The position which the fragments may take when the fracture occurs is a very interesting study. For purpose of simplification, it is best to speak always of the proximal fragment in its relation to the distal. It may take any one of eight positions,—namely: anterior, anterolateral, anteromesial, posterior, posterolateral, posteromesial, lateral, and mesial. The most frequent position found in this series was the anterolateral, which occurred in eleven cases. Three others were anterior and four anteromesial, making a total of eighteen in all the anterior positions. Only seven were posterior, while in four the proximal fragment was found in lateral displacement and in one mesial, without any anteroposterior displacement in either case. The displacement, of course, is due to muscle pull after the rigidity of the limb is destroyed. The flexors of the hip, chiefly the iliopsoas muscle, being stronger than the extensors, the proximal fragment is usually pulled anteriorly. Then, since the adductors are inserted mostly in the distal fragment, the abductors, chiefly the gluteus medius and minimus attached to the greater trochanter, tend to pull the proximal fragment laterally. Add to this the strong gastrocnemius, which can always be depended upon to pull the distal fragment posteriorly, and it is easy to explain the preponderance of anterior and anterolateral positions of the proximal fragment. If the fracture is in the upper third, there will be external rotation of the leg, because the external rotators of the thigh are much in excess of the internal rotators, there being only three of the latter,—namely, the tensor fasciae femoris, gluteus minimus, and gluteus medius.

If all these facts are kept in mind when one undertakes the reduction of a fractured femur, the reduction may be more easily accomplished. These facts also explain why the Bryant perpendicular extension method usually gives the best reduction in children. By this method we get at

once a flexion and abduction of the thigh, thus bringing the distal fragment into line with the flexed and abducted proximal fragment. It was first used in 1898 at the Johns Hopkins Hospital, and since then has been the method for children.

In Clark's series the overhead extension was used in twenty-one cases. In fifteen of these a good reduction was obtained, but in six the result was not satisfactory and the fracture was reduced under anaesthetic and a spica cast applied. In one of these six an outward bowing had resulted because the child walked too early and open reduction had to be done. A fairly good alignment was maintained in a spica without internal fixation of any kind, but a shortening of two centimeters persisted. This child was seven years old, and, when last seen, twenty months after the fracture, she had not made up any of this shortening. Of the fifteen satisfactory overhead extension cases, three had spica casts applied after the extension was removed and kept on from two to three weeks as a protection against falls. In the remaining twelve the extension was removed in from two to four weeks, depending upon the age. Massage and motion were carried on for two or three weeks more before weight was allowed.

The horizontal Buck's extension was tried in but two cases and failed

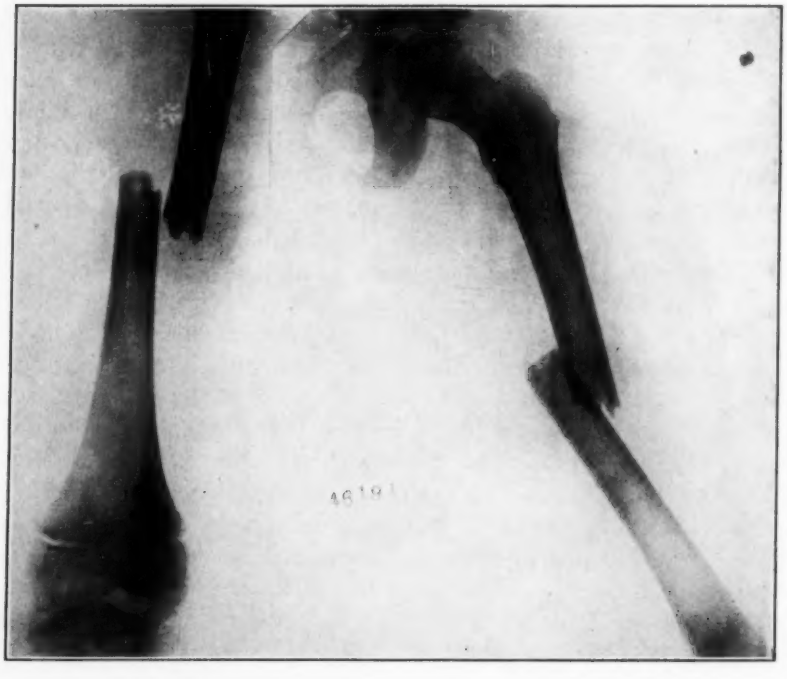

FIG. 24-A FIG. 24-B

Fig. 24-A and Fig. 24-B. Roentgenograms of patient, P. P., white male, age four, who was injured May 3, 1920, by having an automobile run over left leg, receiving transverse fracture of middle third, left femur. Patient was given ether anaesthetic, reduction of fracture was carried out and plaster cast applied, as in Fig. 1. Patient remained in plaster cast for 39 days.

to produce a satisfactory reduction in either case. This method was introduced by Gurdon Buck of New York in 1861, but in Garrison's "History of Medicine" it is stated that Guy de Chauliac, a French physician, who lived from 1300 to 1368, treated fractures of the femur by means of weights and pulleys. It was the most popular method until Cushing began to use spica casts in 1898. With the same amount of weight much more can be accomplished with the hip sharply flexed than in the extended position. These two patients were eight and ten years old and both had to have open reductions.

To obtain a union in any fracture, which means formation of callus, it is not necessary to have the fragments rigidly immobilized, including the joints above and below. In fact, a callus will form more quickly and more abundantly if some motion is allowed. This is well demonstrated in specimens of fracture found in birds and wild animals, an excellent collection of which may be seen at the Army Medical Museum in Washington. Many of these show union, presumably without any treatment whatever, but the alignment and length, of course, are very poor.

The Hodgen splint, introduced by John Thomas Hodgen of Kentucky, who lived from 1826 to 1882, is a good device for holding a femur with hip and knee flexed; but in Clark's hands the Thomas splint with the Pierson attachment for the leg below the knee is more adjustable to the size of the patient.

In the overhead suspension, Clark sees no reason for suspending both legs. In fact, it seems that better abduction can be obtained by tying up only the fractured one. Also more weight and counterweight is available by the one-leg method, because with the sound leg holding up part of the body weight, that much of the counterweight of the body is lost. Enough weight is attached to raise the patient's buttock off the bed, the number of pounds varying from five to twenty.

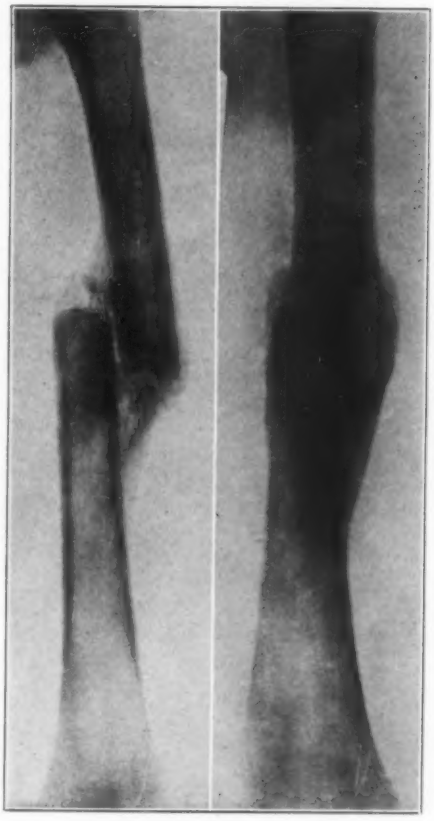

FIG. 25-A FIG. 25-B

Fig. 25-A and Fig. 25-B. Roentgenograms showing results of patient P. P., with 2.5 cm. shortening, with poor alignment. Patient had perfect reduction following the administration of ether anaesthetic, as previously stated. The poor position and alignment are the results of muscle pull, and would not have happened if continuous traction had been applied.

FIG. 26

Roentgenogram of patient H. H., white female, age 6, who was injured on May 6, 1921, by automobile, receiving oblique fracture middle third of right femur and was treated in plaster cast only. This patient had a shortening of 2 cm.

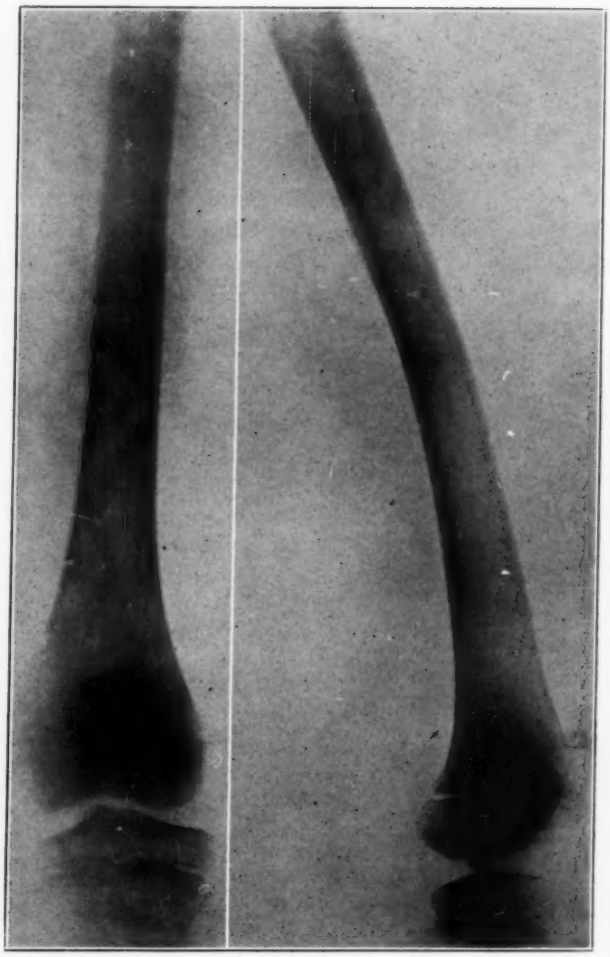

FIG. 27-A FIG. 27-B

Fig. 27-A and Fig. 27-B. Roentgenograms of patient H. H., a few years later, showing compensatory lengthening of 2 cm., following oblique fracture middle third right femur. Perfect functional results.

Four cases out of the thirty-one required open reduction,—because of union with overriding in one, one because muscle interposition prevented reduction, one because of union with outward bowing mentioned above, and one because the distal fragment was short and locked in bad displacement. Internal fixation was used in only two of these, a Lane plate in one and Kangaroo tendon in the other.

Six cases were reduced under anaesthetic within thirty-six hours and a spica cast applied. These were all transverse fractures in which it was thought possible to get the fragments into end-to-end approximation by

manipulation. To insure a good result the fragments must be made to lick, thus maintaining the normal length. In one of these there was a shortening after union of one and five-tenths centimeters, in another five-tenths centimeters, in four no shortening, and one could not be traced.

U. G. POULSEN

Poulsen[9] recommends the use of a plaster spica, which is applied while traction is being exerted on the leg and the hip being flexed to a right angle. With this method he has been able to obtain good results in some cases in which overhead extension had failed to reduce the deformity.

LAWSON THORNTON

Thornton[10] reports one case of plaster traction apparatus, plus skeletal traction, employed in a case of fracture of the shaft of the femur in a boy seventeen years old, who was brought into the hospital eight hours after injury in an automobile accident. In addition to compound comminuted fracture of the left femur, the left tibia and fibula and left olecranon process were also fractured. After caring for the latter fractures, a plaster traction splint was applied in the following manner: A suit of stockinet was put on, extending from the toes to the axillae. A large thick piece of piano felt was placed underneath the whole of back and along each side of pelvis and hips. The right foot and leg were well padded with many layers of sheet wadding bandage, and a spica cast applied from the toes of the right foot to the mid-thorax, and down to a point six inches above the point of fracture of the left femur. The traction splint, consisting of two lateral bars with a ratchet windlass, was incorporated in the cast. Pieces of board, held in place by plaster bandages, served as braces to stabilize the splint and to act as a trellis support. The splint was applied at such an angle that the desired degree of flexion and abduction of the left hip might be obtained. A canvas hammock was pinned to the lateral bars to support the weight of the left thigh.

Briefly, traction under such conditions is transmitted as follows: When the ratchet windlass is tightened, the webbing tape draws the caliper ice tongs along with the lower fragment downward. Countertraction is exerted on the sole of the opposite foot against the lateral surface of the left side of the pelvis and hip. Such powerful traction may be exerted that, as in this case, the fracture may be reduced and alignment restored immediately. Good results were obtained in this case.

This same method is also applicable to fractures of the femur in children and has been used by Hoke and Thornton with excellent results.

W. M. FIROR

W. M. Firor[11] makes a study of fractures of the femur treated at the Johns Hopkins Hospital. He reaches the general conclusions that immediate immobilization in plaster spica does not give satisfactory results in patients over fourteen years of age, but in children it gives results as good

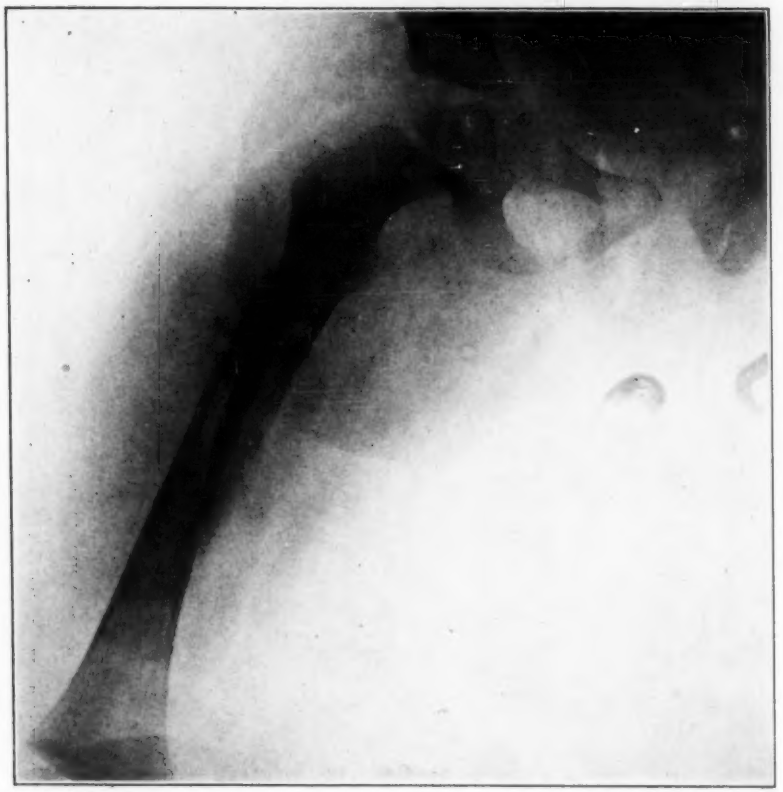

FIG. 28

FIG. 29

Roentgenograms of patient G. G., white female, age 2, with spiral fracture of right femur, injured February 16, 1924, by falling off steps. Patient was treated in plaster cast with full functional results, as in Fig. 29.

as those obtained by overhead extension. By the use of early immobilization in casts,—*i.e.* after a short period in extension, the time spent in the hospital is reduced. There were 102 cases treated by immediate reduction under anaesthetic and application of spica cast. Of these, twenty-two were over fourteen years of age; twenty-seven between seven and fourteen years; and fifty-three, seven years or under.

Firor states that in 1889 on Dr. Halsted's service Buck's extension was in vogue and this was apparently the only method used. The fracture was usually reduced the second day under chloroform, then coaptation splints and Buck's extension applied. In ten weeks this was removed, and four or five weeks later the patient was walking.

In 1898 Cushing first used a plaster spica after reduction in a recent case with excellent result. This method then came more and more into use. In the same year, a three-year-old child was put up in overhead extension instead of the usual horizontal. This was maintained six weeks with excellent function and only five-tenths of a centimeter shortening as a result. Since then this has been the method of choice in children.

Firor's description of the early immobilization method in plaster is as follows: If patient is under two years, the fracture is immediately reduced and a double plaster spica is applied; and if position is good, the patient goes home two days later. For patients between two and fourteen a Thomas splint is first applied and patient is made comfortable for two or three days, after which the fracture is reduced under ether and a double spica applied. If reduction is satisfactory, the patient goes home two days later and is visited every week by a nurse. After seven to nine weeks the cast is removed and two weeks later crutches are used. For patients over fourteen years a Hodgen splint is used for three weeks, after which a plaster spica is applied and the patient sent home and treated as described above.

Of seventy-one children under fourteen years, twelve had to have more than one closed reduction and cast. Results from the use of straight Buck's extension show that of fifty-six patients treated by this method, seven had to have open operations. Of the remaining forty-nine, final measurements were obtained on thirty-six; fifteen of these have shortening of one and five-tenths centimeters or more.

The average stay in the hospital of Firor's series was: Buck's extension method, sixty-five days; open operation cases, fifty-seven days; overhead extension, fifty days; plaster spica cases (early and immediate immobilization)—(*a*) over fourteen years, thirty-four days; (*b*) under fourteen years, fourteen days.

BURDICK AND SIRIS

Burdick and Siris[12] report cases of fracture of the femur in children up to the age of thirteen years. Their report incorporates two groups of cases: the first, sixty-seven fractures that were admitted to the service from January 1916 to July 1917; the second, 201 fractures that were admitted from October 1919 to October 1922. These two groups did not include fractures of the femur associated with serious injury to other regions of the

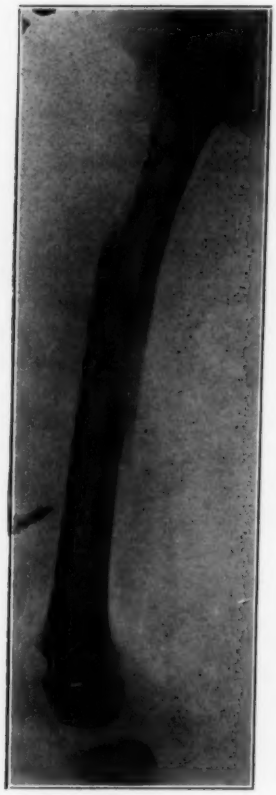

FIG. 30

FIG. 31-A

FIG. 31-B

FIG. 32

Roentgenograms of patient W. W. Jr., white male, age 7, injured September 8, 1922, in an automobile accident, receiving an oblique fracture of middle third of right femur. Patient was treated in plaster cast and extension, with perfect functional results (Figs. 31-A, 31-B and 32).

Roentgenograms (Figs. 31-A and 31-B) and photograph (Fig. 32) were taken in May 1926.

body which resulted in death shortly after admission. The report emphasized the conservative line of treatment, the course followed, and the observations made in the hospital and return clinic.

The majority of cases in which the anatomical approximation of the fracture was not satisfactory were followed for a period of six months to three years. The clinical course showed that perfect anatomical reduction is not essential for perfect functional recovery in children. Marked displacement and overriding of the fragments will usually result in a good functional limb, without appreciable deformity, tilting of the pelvis, or compensatory curvature of the spine. Burdick and Siris also demonstrated that shortening, which existed on discharge from the hospital, was not always permanent, and a number of cases, where shortening existed at the time of discharge, within a year or two subsequently presented an appreciable lengthening. This lengthening was frequently present when operative intervention had been resorted to in the reduction of the overriding fragments. The lengthening was not due to overcorrection of the overriding except in two cases in which calipers were inserted.

Stimulation of the growth of bone in its longitudinal direction occurred in the fractures of the diaphysis, irrespective of their location in the shaft; in no case was there any involvement of the epiphysis when subsequent lengthening ensued. In the cases of extreme shortening no disability resulted, the shortening being compensated for by slight tilting of the pelvis, which was difficult to detect.

The various methods of treatment by Burdick and Siris are grouped as non-operative and operative, as indicated in Table IV of their report, as follows:

Non-operative

Bryant frame and suspension	96
Thomas splint and traction	14
Hodgen splint and traction	2
Plaster spica and traction	118
Hamilton side splint and traction	2

Operative

Lane plating	6
Open reduction	6
Calipers	5
Steinmann pin	2

Combined Treatment

Bryant frame and extension following use of Thomas splint	1
Plaster spica case and extension following the temporary application of a Thomas splint	6
Plaster spica case and extension changed from the Bryant frame	5
Plaster spica case and extension following a Hamilton side splint and extension	5
	268

In the endeavor to make the treatment uniform and readily applicable to as many cases as possible, all the available procedures were given a satisfactory trial in standardizing the treatment on the service. It was found that the more simple apparatus, which would not hinder careful observation and nursing, and which served as a permanent appliance from the inception of the treatment, was the most desirable, even though a longer time elapsed before functional recovery was obtained.

Siris and Burdick state that children up to the age of six years were suspended in a Bryant frame. This form of treatment was employed for older children, but was not encouraged as the great weight of the body will frequently tear off the extension straps, permitting sagging of the fragments and requiring its frequent reapplication.

The type of frame adopted consists of two uprights about five feet long slotted in four places to permit the cross-bar and pulleys, fastened to the upper ends of the uprights, to be adjusted to any desired height. A horizontal bar, to which two pulleys are attached, is fastened to the back of the head of the crib. The uprights have been made of sufficient length to permit raising the buttocks for a bedpan or the changing of linen without the feet coming in contact with the suspension bar, which would allow sagging of the extremities.

Burdick and Siris find that various methods of treatment have been used for the immobilization of fractures in older children, but the most satisfactory procedure is the plaster spica with continuous extension. After reducing the fragments on the Hawley table, and having applied the moleskin or zinc oxide plaster traction straps, the femur is maintained in a position of moderate abduction by means of a plaster spica extending from the malleoli to the ribs, with continuous skin extension, ten to fifteen pounds traction being applied with the foot of the bed elevated. After the plaster spica has hardened, a subsequent radiograph is taken in bed to ascertain if the reduction has been satisfactory. No further treatment is required until the removal of the cast at the end of six weeks. The results from this method have been so uniformly satisfactory that this procedure has been adopted as a routine. There is no limitation in motion of the hip joint, the disability at the knee is only temporary, and before another month has elapsed there is a complete range of motion at the knee unless there is some associated condition limiting flexion. Passive and active exercises are instituted and in two weeks the patient is allowed out of bed on a prone board and crutches, the latter being discarded at the end of another two weeks.

The maintenance of continuous skin traction is used, not with the idea of improving what overriding may exist after reduction, but to attempt to prevent any change in the relative position of the fragments.

Suspension treatment:—As indicated by Burdick and Siris in Table IV, several cases were treated by suspension with the Thomas or Hodgen splint, to observe the efficacy of this method in children between seven and twelve years of age. The children would toss about and tilt the splint to the sides,

FIG. 33-A FIG. 33-B

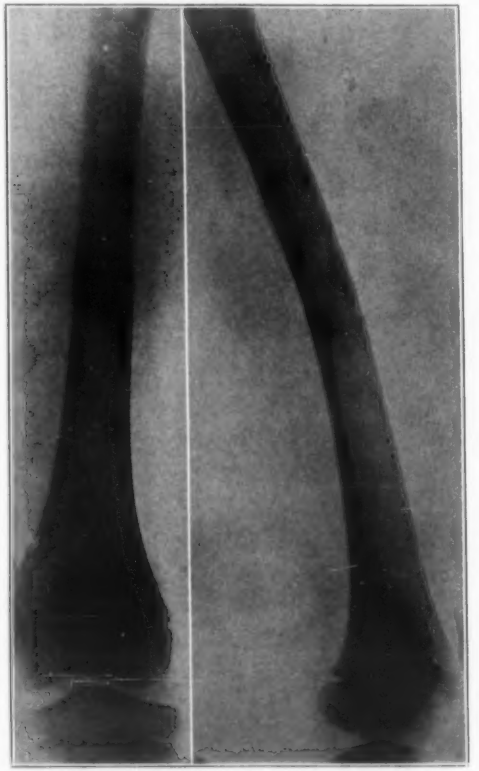

FIG. 34-A FIG. 34-B

Roentgenograms of patient R. N., colored male, age 6, who received a transverse fracture of middle third of right femur on December 26, 1924.

Patient was treated in extension and suspension, and results were excellent, as in Figs. 34-A and 34-B and 35-A and 35-B. Roentgenograms and photographs taken in May 1926.

FIG. 35-A

FIG. 35-B

the rings were either too small or too large, occasionally the ring would become moist or the skin traction would slowly slip down over the heel and malleoli, producing a sloughing of the skin unless carefully guarded against. In cases where the knee was flexed and the extension made only on the thigh, the constant wriggling of the patient, who only occasionally cooperated, would frequently tear off the skin traction. This method requires constant vigilance and care, and the advantage claimed, in that active and passive motions are begun at the outset with consequent earlier functional recovery, does not warrant its use as a routine in preference to the plaster cast.

In children there is no advantage of the Hodgen splint over the Thomas splint. The latter is recommended for the immobilization of the fracture, if the condition of the patient is so serious that an anaesthetic is contraindicated for the application of a plaster spica, in the majority of compound fractures, and in cases in which skeletal traction is required.

In the first group of sixty-seven cases an open operation was performed in five, a percentage of seven and five-tenths per cent., and in two a Steinmann pin was inserted. In three of the open operations Lane plates were used; one was reduced after cutting down on the fragments; and in the fifth the fragments were reduced and held in place by kangaroo tendon.

In the second group of 201 cases open operation was resorted to in seven, a percentage of three and five-tenths per cent. In three cases Lane plates were inserted, three were reduced after cutting down on the fragments, and the seventh, an oblique supracondylar fracture, was held in position by the insertion of a wooden screw. Calipers were used in five cases, four of which were suspended in a Thomas splint and one in a Bryant frame.

The conclusions reached by Burdick and Siris are as follows:

Fractures of the femur in children are almost invariably followed by a good functional result. A satisfactory anatomical reduction is not essential for perfect function.

Children up to the age of six years are best treated in a Bryant frame; over six, in plaster spica with traction.

Suspension treatment in a Hodgen or Thomas splint is not practical, except in compound fractures, simple fractures with laceration, or severe trauma to adjacent tissues, where the administration of an anaesthetic is contraindicated, and when skeletal traction is to be employed.

The majority of cases which are discharged with shortening will be corrected spontaneously within one to two years.

A certain number of cases, irrespective of the form of treatment, will be followed by a lengthening of the fractured side.

An open reduction is rarely indicated, as skeletal traction will almost invariably correct any marked deformity.

L. B. JOHNSTON

The general concensus of opinion relative to the treatment of fractures of the shaft of the femur in children, according to Johnston[13], seems to be

FIG. 36-A

FIG. 36-B

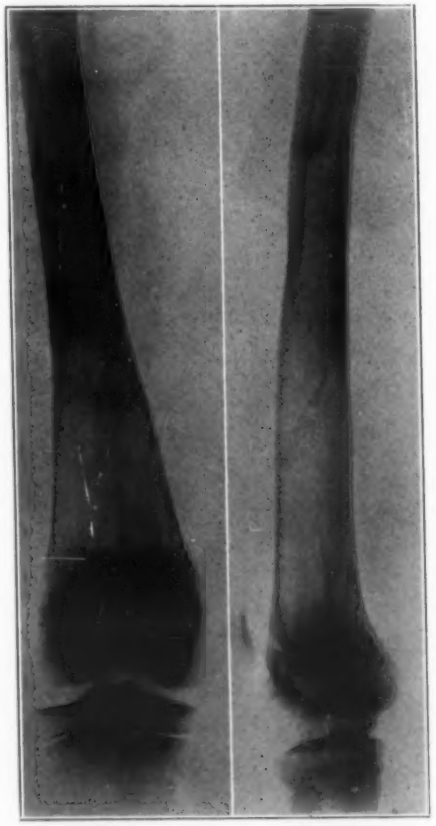

FIG. 37-A

FIG. 37-B

FIG. 38

Fig. 36-A and Fig. 36-B. Roentgenograms of patient M.G., white male, age 11, who was injured February 1924, receiving a spiral fracture of the lower third of right femur. Patient was treated in extension and suspension with full functional results, good alignment, union and position, and no shortening, as in Figs. 37-A, 37-B, and 38.

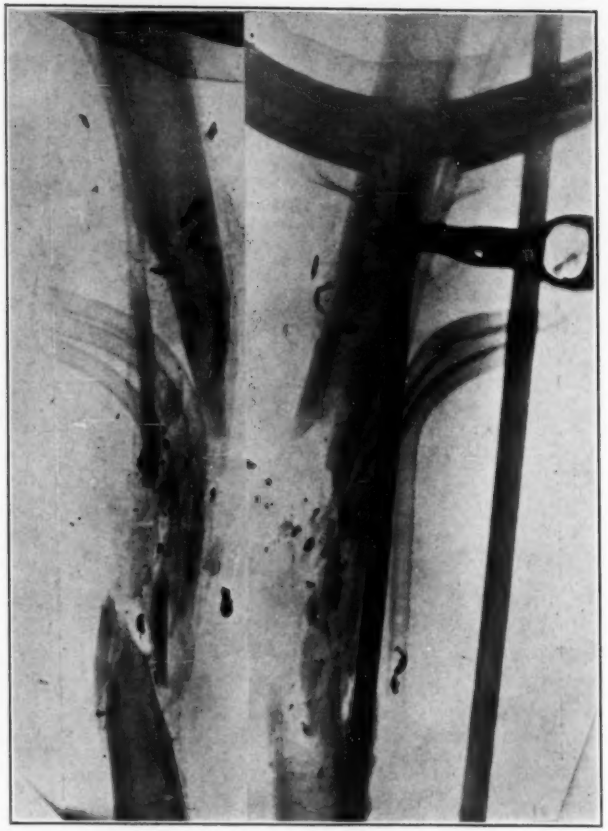

FIG. 39-A FIG. 39-B

Fig. 39-A and Fig. 39-B. Roentgenograms of patient L. J., colored male, age 7, with severe compound, comminuted fracture — gunshot wound — of the middle and lower thirds of right femur, injured December 12, 1923. Patient was treated in Thomas splint and developed severe infection. Incision and drainage were necessary and Dakinization was carried out. Patient was later treated with suspension and extension, and he received full functional results with good union and good position, as in Figs. 40-A and 40-B. Fig. 40-B shows a small sequestrum, which was removed, and wound healed without any further complications. Patient did not have any shortening. Roentgenograms (Fig. 40-A and Fig. 40-B) were taken in Nov. 1924.

FIG. 40-A FIG. 40-B

that good functional results may be obtained by the universal application of one or two of the methods now commonly used. Although this may be true to a great extent, he believes that each case should be handled as a separate problem; that the type of treatment instituted should depend upon the character of the fracture and the age of the child; and that by the proper application of the most suitable type of treatment anatomical results can be more nearly approached. With these thoughts in mind a study was made of thirty cases of fracture of the shaft of the femur in children under twelve years of age who were treated in Cincinnati General Hospital between February 1, 1922 and January 1, 1924.

Johnston's results are as follows:

Condition on Leaving Hospital:— Shortening: Of twelve successful reductions with one attempt and with immobilization chiefly in the mechano splint or in the double plaster spica cast, there was an average shortening of one and forty-five one-hundredths centimeters.

Of five unsuccessful reductions, which were treated largely in double spica casts, there was an average shortening of one and forty-five one-hundredths centimeters.

Of twelve cases, chiefly oblique, treated in Bryant's extension or in traction splints, there was an average shortening of forty-five one-hundredths centimeters.

It is definitely shown that greatest shortening resulted in the cases which were reduced and immobilized in the double spica cast.

Angulation: Gross angulation of slight degree was noted in but three cases on discharge, all of which had been treated in casts.

Callus: Usually there was considerable palpable callus on discharge. Records on this subject are not complete enough to determine whether the amount of callus which develops depends in any way upon the type of immobilization. There were no cases of delayed union in the series.

Joint Motion: Motion of the hip joint seems to be affected only in high upper third fractures, and in those cases there is only slight limitation.

In fractures of the middle third treated in Bryant's extension or in the double spica cast, there is usually fifty per cent. limitation of motion of the knee joint, which returns to normal within three or four months.

In low fractures of the lower third, the motion of the knee joint is markedly limited, but here also it rapidly returns to normal.

Discussion of Johnston's Methods

Johnston's experience with recent cases and the results of the above analysis have led him to formulate certain ideas relative to the application of various methods of immobilization.

Unless his cases were associated with other serious injuries and shock, he immediately fluoroscoped the limb. If the fracture were transverse, immediate reduction was attempted. If it were oblique, he immediately placed the limb in the type of traction decided upon. With cases in moderate shock, immobilization in the mechano splint with considerable

traction was employed. With cases in severe shock, immobilization with a board splint extending to the axilla was used.

Although Johnston's records showed that he made a number of successful reductions after immobilization for two or three days in a temporary splint, it is true that immediate reduction is more easily effected and should be attempted before swelling and infiltration of the tissues has occurred. Therefore, if the condition of the patient permitted, he attempted a reduction immediately.

In children from one to five years of age, Johnston believes that all types of fracture of the shaft of the femur, with the exception of those of the lower third, can best be treated in Bryant's extension. He successfully used this method in infants as young as ten months. It is particularly good in fractures of the middle and upper thirds where the upper fragment is usually anterior. The adhesive traction straps are placed up to the level of the fracture. Enough weight is used to keep the buttocks just a little off the bed. Only one leg is suspended so that the maximal traction is obtained. Both legs are suspended only in young infants where it may become necessary to prevent excoriation of the buttocks. As advised recently by Burdick and Siris, approximation of the ends of fragments in transverse fractures is accomplished before the leg is suspended.

In children between the ages of five and ten years, the treatment of fractures of the middle and upper thirds depends upon the character of the fracture. If the fracture is transverse, it is reduced and immobilized in what is called the "Mechano splint". (This splint is merely an adjustable Thomas splint for children, which was devised by French; the only account of this splint found is a description by Chapman.) The mechano splint is applied and then the fracture reduced on the fluoroscopic table. Slings are arranged to support the leg properly, and sometimes are utilized to hold the fragments in apposition. For a week or two the leg is kept rather snugly laced in the splint. Just enough traction is used to immobilize the leg, very little being necessary in these transverse fractures. The ring of the splint is padded and protected with oiled silk to keep it dry. Only in one case was trouble encountered because of excessive soiling of the ring. Slipping of the fragments, resulting in overriding, seldom occurs. The patient is taken to the fluoroscopic room every few days for the first two weeks. He can sit up readily in bed; he can be moved from the bed to the stretcher with perfect safety; the splint may be suspended in bed if desired; and abduction may be used if it is helpful.

In several cases the splint was used for two or three weeks, and the patient sent home in a single or double plaster spica cast. The splint was used also in cases of compound fracture, which had been subjected to debridement and reduction. It is particularly adaptable to middle third fractures. It was used successfully in one transverse fracture of the upper third. In no cases were excoriation or ulceration of the perineum present. The splint is not adaptable to females, and an iron stirrup, held in place by a snug plaster ring about the thigh, was substituted in their treatment.

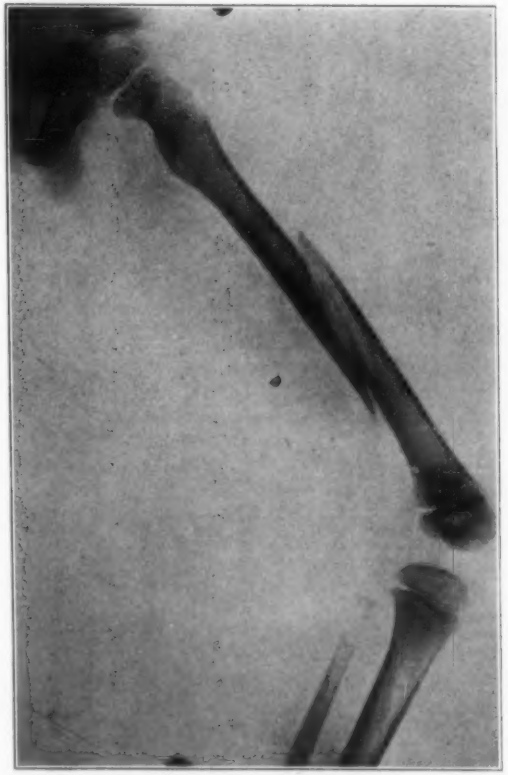

FIG. 41

FIG. 42-A

FIG. 43

Roentgenograms of patient J. N., colored female, age 3, showing fracture at the juncture of middle and lower thirds of left femur. Patient injured July 12, 1922. Treated in suspension and extension, with perfect functional results and no shortening —as in Figs. 42-A, 42-B, and 43. Photograph (Fig. 43) was taken in May, 1926.

FIG. 42-B

The other method for treating transverse fractures in children between five and ten years of age is reduction and immobilization in the double spica cast. Johnston agrees with Speed that this is a most undesirable method, and in his hands it has given the most unsatisfactory results. Its disadvantages are: that the fragments often slip; that it is difficult to handle or fluoroscope the limb; and that malposition, if it occurs, is not discovered for a week or more, when attempts at reduction are futile, the result being union with from one to two and five-tenths centimeters of shortening. When he did resort to the cast method the double plaster spica was used, completely surrounding the affected limb and the thigh of the unaffected limb. The cast is carefully trimmed, the patient is turned face downward twice daily for an hour, and if the patient is an infant, the buttocks are suspended over a gap between two folded mattresses to prevent soiling the cast.

In the treatment of oblique fractures of the shaft of the femur in children between five and ten years of age, Bryant's extension was used and good functional results obtained with less than one centimeter of average shortening. It is applicable to fractures of the middle and upper thirds.

Fractures of the lower third of the shaft of the femur in children of all ages, unless they are of such transverse character that the ends of the fragments can be securely approximated, constitute a separate problem. Treated in Bryant's extension or in extension splints, the lower fragment tends to be pulled backward by the gastrocnemius muscle. Johnston treated these fractures by using the double plaster spica with the knee flexed to forty-five degrees. In one case, a window was cut anteriorly in the cast just above the knee and, by means of a sling and a windlass, traction was exerted to lift the lower fragment forward. This method must be used with great care in order to prevent injury from pressure in the popliteal space. The unusual cases in which the lower fragment is forward and in which the oblique fracture line runs from behind, upward and forward, may be treated in Bryant's extension. Johnston never had to resort to open reduction in the treatment of fractures of the lower third. In his opinion, this is the only type of simple fracture of the shaft of the femur in children where an open reduction would be justified, and then only after an unsuccessful attempt with a closed method.

In children over ten years Johnston states that the problem of the treatment of fractures of the shaft of the femur becomes comparable to that in adults. Bryant's extension is no longer applicable because of the tension on the hamstring group of muscles. In general the cases recorded by him have been treated in the mechano splint or in the double spica cast. However, in two recent cases not included in this series balanced traction was used, a method which is used in all of the adult cases, and which has recently been reported by Dr. Andrus. Both these patients were discharged without shortening.

The femur cases in children are immoblized for from four to six weeks. Then, if the patient is under six years of age, he is merely kept from walking or standing, and if he is over six years of age, he is provided

with a splint consisting of an iron stirrup held in place by plaster about the thigh. In older children this may be made as an ambulatory splint. Weight-bearing is not allowed under three months.

Johnston's conclusions are as follows:

1. Each fracture of the femoral shaft in children should be handled as a separate problem.
2. The choice of the type of treatment should be governed by the character and location of the fracture and the age of the child.
3. Immediate reduction and immobilization should be attempted.

V. C. DAVID

David[14] reports a series of seventy-five cases of fractured femur, which were treated on the Joint Service of Dr. George G. Davis, at the Cook County Hospital between January 1, 1922 and January 1, 1923.

The discussion of David's methods of treatment is not taken up, because his methods almost coincide with the average type of treatment of the previous surgeons. This series is mentioned here on account of the excellent presentation regarding compensatory lengthening.

David's method of measurement was as follows: As soon as the leg was removed from the overhead extension new roentgenograms were taken, and careful measurements of the injured and uninjured femora were made. As the accuracy of the measurements may be questioned, it may be said that the patient was placed on a hard table with all clothing off, with the anterior-superior spines of the pelvis on the same level and with the heels equidistant from a line running from the umbilicus through the symphysis pubis to the level of the internal malleolus of the tibia. Measurements were made by David in the majority of the instances from the anterior-superior spine to the tip of the internal malleolus. In many cases measurements of the femora alone were made, to ascertain that the shortening present was really in the femora. As these patients returned to the fracture follow-up clinic which David held every week, observations, measurements, and roentgenograms were made repeatedly over a period varying from two months to nearly two years after the time of injury. In all, seventy-one of these seventy-five patients were observed, the remaining four refusing to return to the follow-up clinic.

At the time of removal from the overhead extension the shortening varied from two inches (5 cm.) in one patient to no shortening. In Table I David shows the amount of shortening present at the time of removal from the overhead traction, which averaged six weeks from the date of injury.

In thirty-seven patients of the series observed by David a shortening of one-half inch (1.3 cm.) or less, was of little consequence and produced no deformity or limp; but a shortening of over one-half an inch (12.7 mm.) was not lightly regarded, and was often associated with a slight or pronounced limp. It was with especial interest and with some anxiety that these patients were followed, as the question of operative correction of the

TABLE I. (DAVID) — SHORTENING NOTED ON REMOVAL OF TRACTION

Shortening Inches	Number of Patients
None	9
1/8	2
2/8	11
3/8	10
4/8	14
5/8	3
6/8	10
1	9
1 1/4	2
2	1

more marked instances of shortening obviously deserved consideration. As time went on, it became apparent that the injured and shortened legs were becoming longer and that the limps were disappearing. This could not be due to stimulation of epiphyseal lines such as occurs in osteomyelitis near the epiphysis, as these fractures were not near the epiphyseal lines. The overgrowth must be compensatory and a response to the law of compensation for restoration of impaired function.

In Table II David shows the return toward normal length in the incomplete cases. Most of the cases are the more recent ones, in which there is reason to believe that the shortening of the injured leg eventually will be overcome. The most striking instance in Table II is the presence of two inches (5 cm.) shortening, which has been reduced to one inch (2.5 cm.) shortening in nineteen months.

In Table III, 47 completed cases, he gives the amount of shortening at the end of the period of overhead extension, and the average length of time which elapsed before the injured femur attained the length of the normal uninjured femur.

TABLE II. (DAVID) — RETURN TOWARD NORMAL LENGTH IN INCOMPLETE CASES

Shortening Inches	Time Months (Average)	Number of Patients
2 to 1	19	1
1 1/4 to 3/4	5	2
1 1/4 to 1/2	7	5
3/4 to 1/2	5	3
3/4 to 1/4	8	4
1/2 to 1/4	4	6
3/8 to 1/4	5	1
3/8 to 1/8	2	2

No attempt will be made to explain the principles underlying the compensatory overgrowth of these shortened femora. It has been observed before, and some reference is made to it in the literature. Truesdell reported five cases in children in which lengthening of the affected femur was noticed in place of shortening that had been present at the time the patients left the hospital. The fractures did not involve the epiphysis.

TABLE III. (DAVID) — AMOUNT OF SHORTENING AND TIME ELAPSED BEFORE FEMUR ATTAINED NORMAL LENGTH

Shortening Inches	Number of Patients	Return to Normal (Mos. Av.)
1	4	15
¾	3	9
⅝	3	9
½	8	5
⅜	7	5
¼	11	3
⅛	2	2
No Shortening	9	..

The fact that compensatory overgrowth of a shortened femur after the fracture may be expected in a growing child is of extreme importance in further limiting operative interference in these cases.

Another point of interest in treating these cases, according to David, is that alignment of the fractured ends to prevent angulation, and extension to prevent overriding of the fragments, are of greater importance than end-to-end apposition of the fragments. Such apposition is desirable, but union takes place without it, provided marked overriding is prevented. The late roentgen-ray study of fractures in which no end-to-end apposition was obtained shows a restitution of the shaft practically to normal.

W. H. COLE

Cole[15] reports a series of thirty-one cases of fracture of the femur in children and emphasizes the restitution of the shaft practically to normal, and its compensatory lengthening. Fifteen more cases have been observed since then. He was able to follow up and observe only twenty of this total of forty-six cases for more than one year. Of these twenty cases, fourteen presented no shortening whatever when examined one year or more after fracture. Three presented shortening varying between one-quarter of an inch and three-quarters of an inch; but these patients were seen only slightly more than one year from date of injury. Since it is generally agreed that lengthening takes place as late as two years after injury, it is safe to assume that the shortening in these cases will lessen, if not entirely disappear, within the next year or two. The three remaining

patients were observed for two years or more following fracture and still presented one-quarter to three-quarters of an inch shortening. Two of these patients, both of whom were operated upon because of delay in proper union when shortening demanded temporary internal splintings, presented femora with either a marked anterior or lateral bowing. Even in these two patients compensatory growth may have taken place, but was probably counteracted by the bowing deformity of the shaft. Six of the patients who returned were studied very closely and thorough roentgen-ray examinations were made.

In addition to David's technique of measurement, in order to eliminate or detect any source of error in measurements from the x-ray plates, Cole superimposed a rule with a metal marker at each inch of its length parallel to the shaft of femur and tibia on each side about two inches above the film. He feels that by taking precautions the comparative measurements of each shaft of the femur on the x-ray film represent a very accurate comparative measurement and distinctly more accurate than measurement between bony landmarks on the child's body.

Cole reports four cases of compensatory lengthening of fracture of the shaft of the femur in children—ages four, three, nine, and five years. It has been noted that compensatory lengthening will take place in the majority of cases of fracture of the femur in children. The amount of lengthening varies in each patient and is not dependent upon any form of treatment. It has been Cole's experience, when treating fractures of the shaft of the femur in children, that overhead traction offers the most comfortable and efficient method for restitution to normal function. It is desirable to get good alignment of fragments, and perhaps more important than to overcome all of the shortening, provided some portion of the ends of the fragments are in contact. It has also become apparent that operative reduction of fracture of the femur in children is very rarely indicated, since deformity is so completely eradicated within two or three years after fracture, even though the fracture be transverse. Operated cases have given much less satisfactory end results, because of bowing of the shaft after the Lane plates have been removed. The only patient who was treated with an intramedullary peg, returned two months afterwards with a refracture at the site of the previous fracture. Incidentally this was the only case of refracture that was known to have occurred in this series of cases.

Cole's conclusions are as follows:

1. Compensatory lengthening will take place in the majority of cases of fracture of the femur in children.

2. The location of compensation may be found in the tibia as well as in the femur.

3. Rarely is there indication for operative reduction.

4. Abnormal bowing of the shaft serves as one of the greatest factors of deformity and disability and in this series was seen only in operated cases.

T. G. ORR

Orr[16] concludes that there is a definite tendency for fractures of the femur in children to show a compensatory growth and overcome shortening, and often to such an extent that the fractured femur becomes longer than the uninjured. There is also a tendency for rotation and angular deformities to decrease as the child grows; and after knowing the restorative power of the injured femur in the young, operation will rarely be resorted to in order to obtain good functional results. These conclusions are drawn from a case treated by Orr of a boy eleven years of age, who had a transverse fracture of the femur, upper third right. He was first treated by the Hodgen splint with very little traction, and as a result developed two inches overlapping. At the end of two weeks his apparatus was changed, his leg placed in a typical Hodgen splint with Buck's extension. Although the weight was increased, it was not possible to completely overcome the overlapping and the fracture united with one inch of shortening. He was repeatedly x-rayed and operation was considered. Knowing the tendency of femur shortening in such fractures to be compensated by overgrowth, operation was given up. A cast was applied, and at the end of four weeks the boy was allowed to go home. He wore this cast for four weeks, when it was removed and he was kept in bed and chair for four weeks. At the end of that time, he was permitted to walk with crutches and to begin to bear some weight. In six months he was doing regular eighteen-hole duty as golf caddy. He had one-half inch shortening of the injured femur when examined eight months after injury.

KIDNER AND LAKOFF

Kidner and Lakoff[17] call attention to the fact of muscle interposition in fractures of the femur. All of the cases reported by them are adults. However, the fact is mentioned here as a possibility to be considered in the treatment of children, and their conclusions are presented for this reason:

1. If the fragments of a fracture of the femur are not brought into actual bony contact by properly applied traction within three or four days, the case should be viewed with suspicion.

2. If specially worked-out methods are not successful immediately thereafter, manipulation under an anaesthetic should be employed. This attempts to disengage the fragments from the muscle. Such disengagement can usually be recognized by the clean, clear-cut rubbing of the fragments on each other.

3. If, after such manipulation and the reapplication of traction, apposition is absent at the end of two or three days, as disclosed by roentgen-ray examination, open operation should be undertaken.

4. At open operation the muscle or fascia bands must be cleaned from the fragments and good apposition obtained. If this apposition is of the end-to-end, interlocking type, then only external fixation splinting is necessary. If there is a tendency of the fragments to displace again, some solid form of internal splint must be used. Gallie's beef-bone plates or

Magnusen's ivory plates and screws or pegs will usually suffice. Both are more simple of application than Albee's grafts. When they will not hold, metallic plates or bands are occasionally necessary.

Conclusions

1. There is unlimited literature on fractures of the femur in children.
2. The following are the main forms of treatment of fractures of the femur in children:

A. Plaster cast

B. Plaster cast and extension { adhesive / calipers / Steinmann pin }

C. Suspension and extension

Method *C* has several subdivisions,—such as: Buck's extension; skeletal traction (calipers and Steinmann pins) in the horizontal or perpendicular position (this method is rarely used and should not be applied except when amputation is being considered or when no other method is applicable. The interference with the epiphyseal growth should always be kept in mind when using skeletal traction in children); suspension and extension of one or both thighs in a perpendicular elevation with adhesive traction to the skin; extension of one or both thighs in a horizontal or perpendicular position, with the aid of the Thomas or the Hodgen splints; or the Bradford frame.

3. Excellent results are obtained by various surgeons by all of the above methods. The suspension and extension method is the most popular.
4. Treatment by open reduction should be the last resort, and usually is not necessary in the treatment of fractures of the femur in children.
5. A summary of the results of the cases treated by plaster cast shows that better results are obtained in the very young than in the older child.
6. A summary of the cases treated in plaster cast and extension shows that better results are obtained in the older child.
7. A summary of the cases treated by suspension and extension shows that better results are obtained in all ages up to the age of ten and eleven years than in either the series treated by plaster cast or in the series treated by plaster cast and extension.
8. Careful physical and radiological examination with careful history of the accident should always be made. Immediate reduction with aid of fluoroscope should be done. Every case of fractured femur should be considered an emergency and immediate treatment should be given following injury.
9. Unnecessary manipulation of the fractured limb should never be done. General anaesthetic, preferably ether, should be given at the time

of reduction, unless general condition contraindicates; and, when this is the case, local anaesthetic should be used.

10. Definite attention should be given to the conservation of the muscle and the motion of the adjoining joints, thereby lessening the prolongation of convalescence, as well as preventing grave deformities and permanent disabilities. To aid this, frequent applications of physiotherapy treatment are recommended. Frequent radiographs should be made.

11. Good alignment is most important,—then bone approximation.

12. It is definitely concluded that compensatory lengthening does take place, also correction of poor alignment, but chiefly in patients before the age of eight years.

13. The suspension and extension method is by far the most comfortable dressing, and best results have been obtained by this method. This method facilitates frequent daily examinations, frequent checks with x-ray, dressings in compound wounds; makes easy the application of radiant light, hot baths, and active and passive motion. All of these make for a shorter convalescence and better functional results.

14. Frequent inspection of the patient should be made at out-patient clinic, following discharge from the hospital, and patient should be kept under observation until entirely well.

15. Granting that compensatory lengthening does take place and that serious misalignments are corrected in fractures of the femur in children, no surgeon is justified in neglecting any one of the important things which should be done immediately following a fracture of the femur.

16. In the treatment of children the mental factor is to be considered at all times.

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AN ADJUSTABLE BRADFORD FRAME*

BY ALFRED O. ADAMS, M.D., ST. LOUIS, MISSOURI**

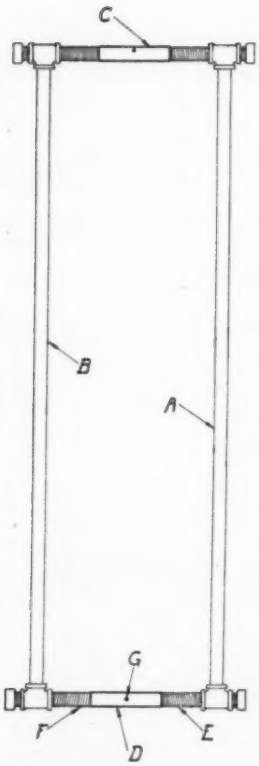

FIG. 1

Adjustable Bradford frame. *A* and *B* lateral bars; *C* and *D* end pieces showing right-handed and left-handed threads, *E* and *F*; *G*, drill hole for insertion of rod to be used as a lever.

The advantages of a Bradford frame that can be adjusted readily to any width between six and sixteen inches will be appreciated by any one who has experienced the difficulty of searching through a pile of old frames in an effort to obtain one that will fit the patient now under treatment.

Figure 1 illustrates the type of frame used in this hospital. It is constructed of standard one-half-inch gas pipe and fittings. This has proved satisfactory for children, but a larger pipe should be used if heavy adults are to be supported. The length is governed by the length of the bed, the frame being about six inches the shorter. On each end of side pieces *A* and *B* is a standard tee. Those on *A* have been tapped out with a right-handed tap and those on *B* with a left-handed tap.

The end pieces *C* and *D* consist of an eighteen-inch length of gas pipe, one half of which has been threaded with right-handed threads (*E*) and the other half with left-handed threads (*F*). A one-fourth-inch hole (*G*) has been drilled through each end piece at the center and a distance of about six inches in the center of each is covered with friction tape to form a hand hold.

By turning the end pieces, the distance between the side pieces can be varied. If the frame covers are applied with the frame set about one-half inch narrower than desired they can be tightened by turning the end pieces to expand the sides. In a like manner the covering can be tightened each morning. A short piece of iron rod inserted into the drill hole can be used as a lever when the end pieces can not be turned by hand.

The use of this type of a frame has resulted in a saving of time. The correct width frame is always available and the covers can be tightened without being removed. It has been welcomed by the nursing staff.

*From the Shriners' Hospital for Crippled Children, St. Louis, Mo.

**This frame was designed and constructed by Mr. Harry P. Werthmuller, Chief Mechanician. Realizing its value the writer felt that it should be brought to the attention of the profession.

A SIMPLE OVERHEAD BED FRAME FOR SUSPENSION AND TRACTION OF THE UPPER AND LOWER EXTREMITIES*

BY ALFRED O. ADAMS, M.D., ST. LOUIS, MISSOURI

The following described overhead bed frame has been constructed in our shop and has been in use for a sufficient time to prove its value and justify its recommendation to the profession. This frame has been designed to provide for any type of suspension and traction of the extremities. The attachments for placing the lower extremities in any degree of wide abduction and for applying traction on an upper extremity are features that are not found on any other frame with which the writer is familiar.

The detailed description may be simplified by considering the frame as divided into three parts:

A. HORIZONTAL PORTION

Figures 1 and 2 show the horizontal portion which consists of two end bars (*1* and *2*) and an overhead bar (*3*). These are connected by joints

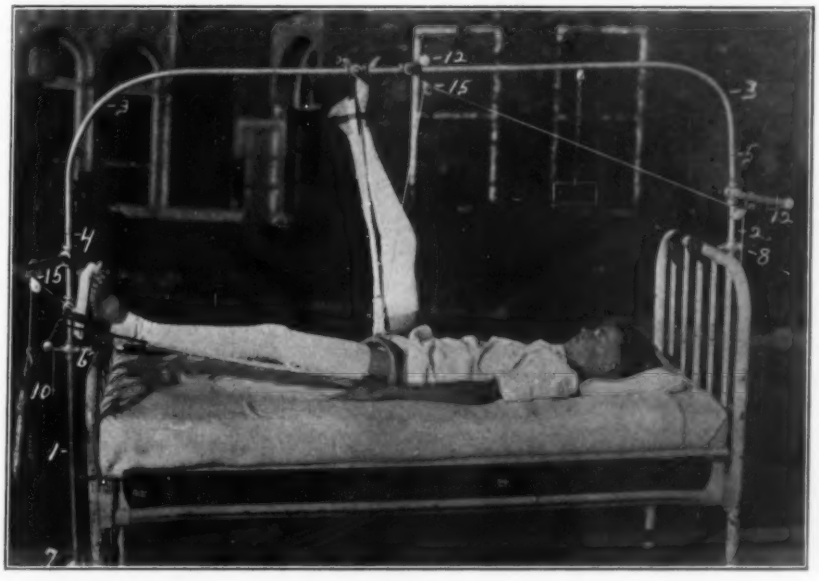

FIG. 1

Horizontal portion of frame. *1* and *2*, end bars; *3*, overhead bar; *4* and *5*, joints between overhead bar and end bars.

*From Shriners' Hospital for Crippled Children, St. Louis.

(*4* and *5*), a detail of which is shown in Figure 4. They are constructed by driving a short piece of solid iron rod into the lumen at the ends of the overhead bar (*3*) and securing with a rivet. The rod projects about three inches and the lumen in each end of the bars (*1* and *2*) is drilled out to form a sliding fit over this rod. These joints are stable and do not interfere in any way with adjusting other parts of the frame.

The end bars (*1* and *2*) are attached to the bed by four specially constructed clamps (*6*, *7*, *8*, and *9*). These clamps (See Figure 4 for detail) are constructed by bending a piece of strap iron to fit the end bars of the bed and by cutting a slot that will fit over the perpendicular bars in the upper and lower ends of the bed. With a thin piece of felt inserted inside the clamp to protect the bed, it is attached to one end of a four-inch length of pipe with a waist nut and four rivets. On the other end of this short piece of pipe there is a standard half-inch cross, with the threads drilled out of two opposite ends to form a sliding fit over half-inch pipe. In the remaining end of this cross a half-inch pointed set screw is placed. The tip of this screw is case hardened to prevent dulling and a quarter-inch hole drilled through it near the other end. A short piece of drill rod (*10*) inserted in this hole serves as a lever for tightening the set screw. An end bar placed through the side of the cross that has been drilled out can be fastened at any point by tightening this screw. When the frame is attached to a bed the upper clamps should face upward and the lower clamps face downward. If placed in this manner, the perpendicular bars in the foot of the bed prevent any lateral motion of the frame.

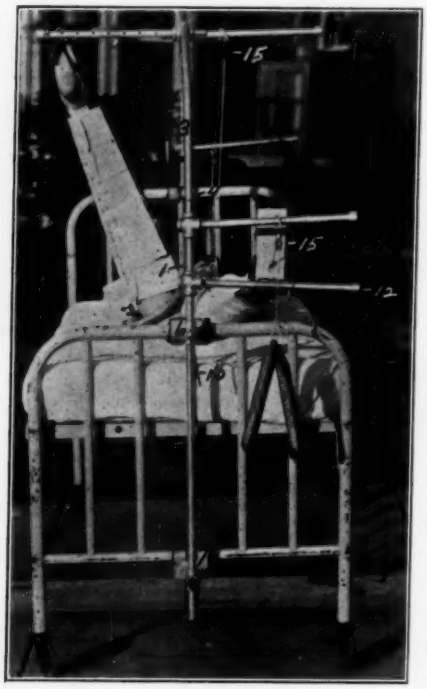

FIG. 2

End view of Fig. 1. *6* and *7*, clamps attaching end bar to bed; *10*, rod for tightening set screws; *12*, cross-arm and cross.

By attaching the clamps to the two end bars in the manner described above, a wide variation in distance between the mattress and overhead bar can be obtained. This is an important adjustment when one of the lower extremities is to be suspended and the height of the overhead bar is to be governed by the length of the Thomas splint available.

Cross-arms have been constructed so that they may be attached or removed with ease and without disturbing any part of the frame that has previously been set up. This connection is shown in detail in Figure 4 (*11*). It is constructed from a half-

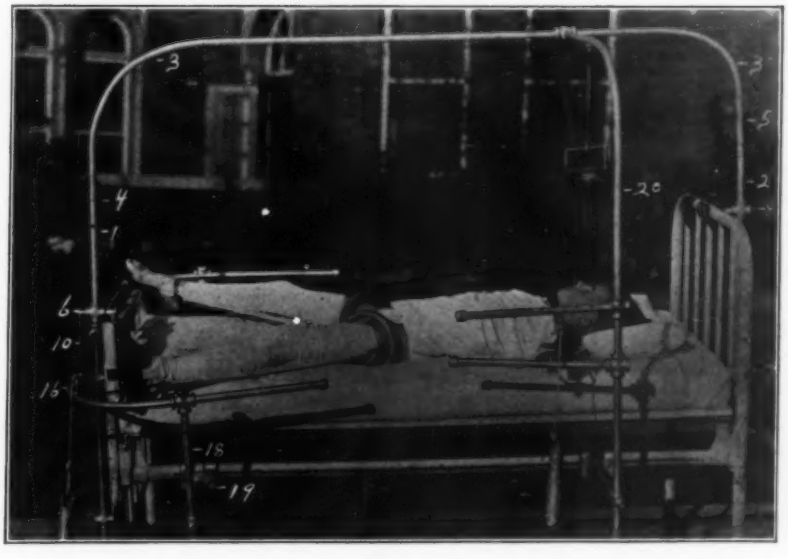

FIG. 3

Complete frame assembled on bed to show attachments for wide abduction of the lower extremities and for traction on an upper extremity.

inch extra heavy steel cross by drilling out the threads in one diameter sufficient to permit a sliding fit over the pipe used in the frame. One side is then cut out and teeth similar to those in a Stillson wrench are cut on the inner surface. It is finally case hardened. The cross-arm (*12*) consists of an eighteen-inch length of pipe with a solid iron tip that has been pointed, threaded, and case hardened. In addition three-sixteenths-inch holes are drilled in the cross-arm every two inches apart. The hole nearest the pointed tip is made one-quarter inch in diameter for the purpose of receiving the drill rod (*10*) which serves as a lever to set the arm in place.

When one of the above described crosses is put on the frame and a cross-arm screwed in either side, the pointed end of the arm and the teeth within the cross engage into the frame to form a solid connection that will safely hold a thirty-pound weight on the end of the arm. If heavier traction is desired, this connection may be further strengthened by placing a second cross-arm or set screw in the remaining end of the cross (Fig. 4—*13*).

Throughout the entire frame an effort has been made to discard all unsightly strings and straps and to make all connections of a mechanical nature and easily adjusted. Thomas splints are secured to the cross-arms by a small metal hook (Fig. 4—*14*) passed through a drill hole and held in place with a wing nut. This allows the patient ample range of motion and at the same time gives efficient countertraction. One-inch awning pulleys (*15*) are attached to the cross-arms by means of a metal hook inserted into one of the drill holes.

B. ATTACHMENT FOR ABDUCTION OF THE LOWER EXTREMITIES

This attachment consists of two long curved lateral bars. The end of one is threaded and a cross attached, while the end of the other (Figs. 3 and 4—*16*) is provided with a case hardened pointed tip connected by a swivel joint. This joint, partially removed, is shown in Figure 4—*17*. Both lateral bars can be attached to the frame with one cross, and the swivel joint affords a means of tightening this joint without turning the entire lateral bar (*16*). Each lateral bar is supported near the curve by an upright (Fig. 3—*18*) consisting of a cross and cross-arm. This upright is supported from the lateral bar of the bed by a clamp (*19*) similar in construction to clamps *6*, *7*, *8*, and *9*, except that the shank is longer.

C. ATTACHMENT FOR ARM TRACTION

This attachment consists of a long piece of pipe bent as shown in Figure 3—*20*. It is attached to the overhead bar with a cross and set screw, and to the lateral bar of the bed with a clamp identical to that used for the abduction bars. Cross-arms may be attached at any level. Both the wide abduction and the arm attachments are eighteen inches from the side of the bed and therefore offer a minimum amount of interference with the nursing care of the patient.

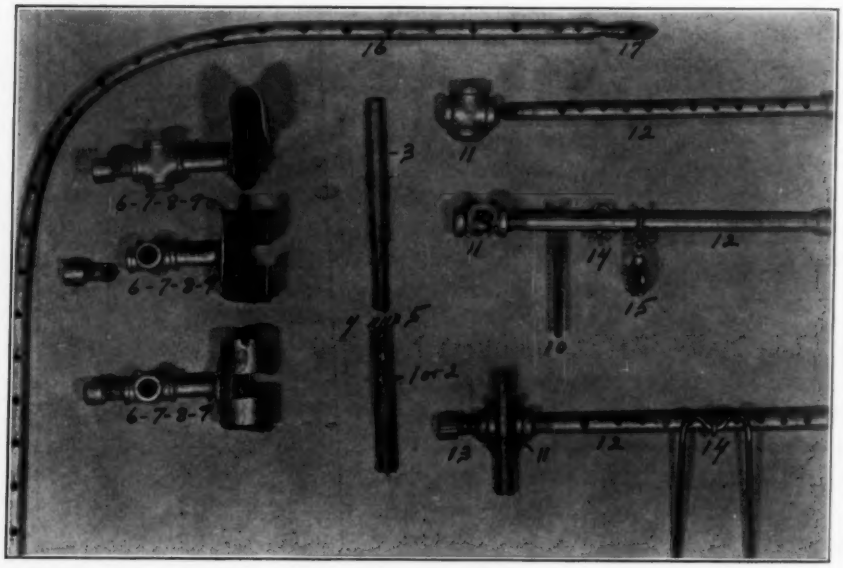

FIG. 4

6–7–8–9, clamps to attach end bars to bed; *4* and *5*, short piece of rod in the end of overhead bar (*3*) drops into lumen of end bar (*1* or *2*) to form a stable connecting joint; *11*, cross attached to short length of pipe; *12*, cross-arm with pointed tip; 13, set screw placed in open end of cross to strengthen connection for heavy traction; *14*, hook for attaching Thomas splint; *15*, pulley; *16*, lateral bar of abduction attachment with tip (17) detached to show swivel joint.

APPLICATION

This frame can be easily assembled without the use of rope, straps, or wrenches and is a valuable aid in the treatment of fractures or correction of deformities of the extremities.

The patient shown in Figures 1 and 2 has a flexion contracture of the left hip that is being corrected by flexing the right hip in order to fix the pelvis and then gradually extending the left hip. This method has previously been described by Abbott[1]. Figure 3 shows the manner in which this frame may be used to hold the lower extremities in wide abduction and to obtain traction on an upper extremity.

The writer is greatly indebted to Mr. H. P. Werthmuller, Chief Mechanician of the Shriners' Hospital, for his cooperation in designing this frame.

1. Abbott, L. C.: The Correction of Deformity in Quiescent Disease of the Hip. J. Am. Med. Assn., LXXXVII, 1095, Oct. 2, 1926.

A DRAIN-STAND FOR PLASTER BANDAGES*

BY HUGH T. JONES, M.D., ROCHESTER, MINNESOTA

Section on Orthopaedic Surgery, The Mayo Clinic

The floor and walls of a room in which a plaster cast is being applied may often be saved needless soiling if the plaster bandages are well drained before they are used.

The drain-stand shown in Figures 1 and 2 was made for use in The Mayo Clinic. It may easily be made by a tinsmith from an ordinary pail. The plaster bandage comes to the operating room wrapped in paraffin paper. The paper is broken at each end of the bandage to admit water freely; the bandage so wrapped is immersed in the water in the pail until bubbles cease to rise and then it is well drained on the drain-stand before the paper is removed. The excess water drains back into the pail. Squeezing or wringing the bandage is not necessary, and hence the crinoline retains a maximal amount of thick creamy plaster that will not drip or splatter.

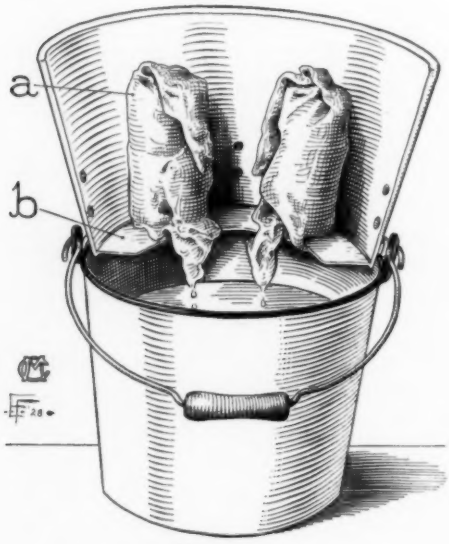

FIG. 1

Drain-stand for plaster bandages; *a*, plaster bandage wrapped in paraffin paper after immersion, and *b*, ledge of drain-stand.

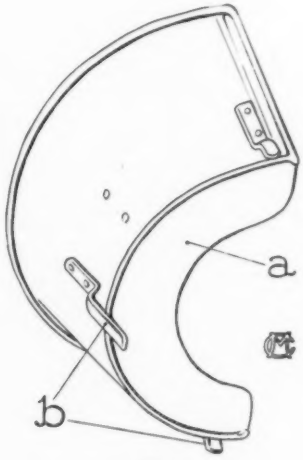

FIG. 2

Details of drain-stand as made from a pail; *a*, ledge of drain-stand, and *b*, clips to hold stand in place over pail.

*Submitted for publication March 6, 1929.

"THE HAMMOCK SPLINT", OR MODIFIED THOMAS SPLINT FOR FRACTURES OF MIDDLE AND UPPER THIRDS OF THE FEMUR

BY SAMUEL R. BENEDICT, M.D., F.A.C.S., BIRMINGHAM, ALABAMA

The modified Thomas splint, as shown in the illustration, is the result of an effort on our part to obtain a more satisfactory method in the treatment of fractures of the middle and upper thirds of the femur. The splint used is a regular Thomas splint with modifications.

First: the diameter of the ring should be increased from three to five inches, depending on the size of the patient. In other words, a Thomas splint should be obtained with as large a ring as possible and then the diameter should be increased at least three inches. The application is the same as that generally used, with the exception that after the leg has been put up with the splint in a horizontal position, the leg and splint are bandaged securely with unbleached muslin from the ring above to the ankle below. Before this unbleached muslin is applied, of course the traction straps are put on, and the leg is also well incorporated in cotton batting.

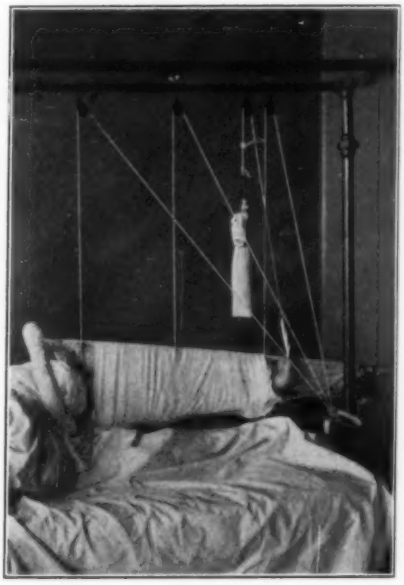

FIG. 1

Patient turned on side, showing position of splint.

FIG. 2

Shows splint in position, overhead frame, and hammock suspension.

After the muslin has been applied, some manual traction is used through the traction straps; and the splint is now rotated into the vertical position,—that is to say, one rod above the other. This allows the leg to rest in a hammock. (See illustrations.)

Second: the regulation traction weights are used, with the exception that a block properly grooved to fit the rods on the lower end of the splint has inserted in it a regular window pulley in the horizontal position, and on the back of this block is applied another block on which the pulley is put on in the vertical position (Fig. 3). The purpose of this is to permit the patient to turn in any position with continuous traction at all times. The overhead frame as shown is not essential, but is of the greatest assistance in that the attendant simply lifts the splint by means of cords which are passed through pulleys in the frame, thus permitting the patient to turn in almost any position without difficulty. It is advisable to have three or four small eyelets welded on the upper side of the Thomas splint so that cords can be more easily attached. The overhead frame is of material benefit in obtaining the desired amount of abduction and if the frame is supported from the floor rather than from the bed it is easier to move and a greater amount of abduction can be obtained.

The proper application of this splint usually means that further attention will not be necessary during the time the leg is to be kept under trac-

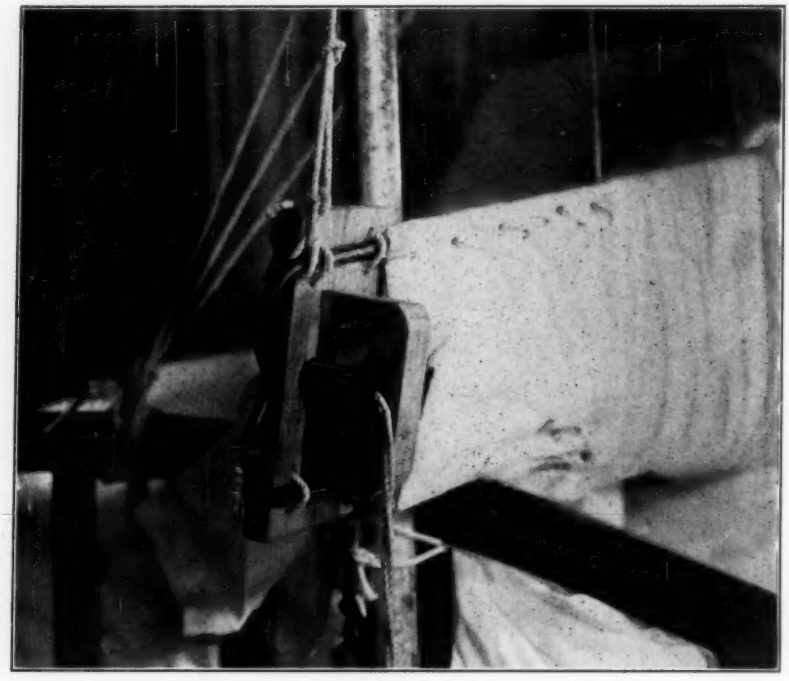

FIG. 3
Detail of block and pulley.

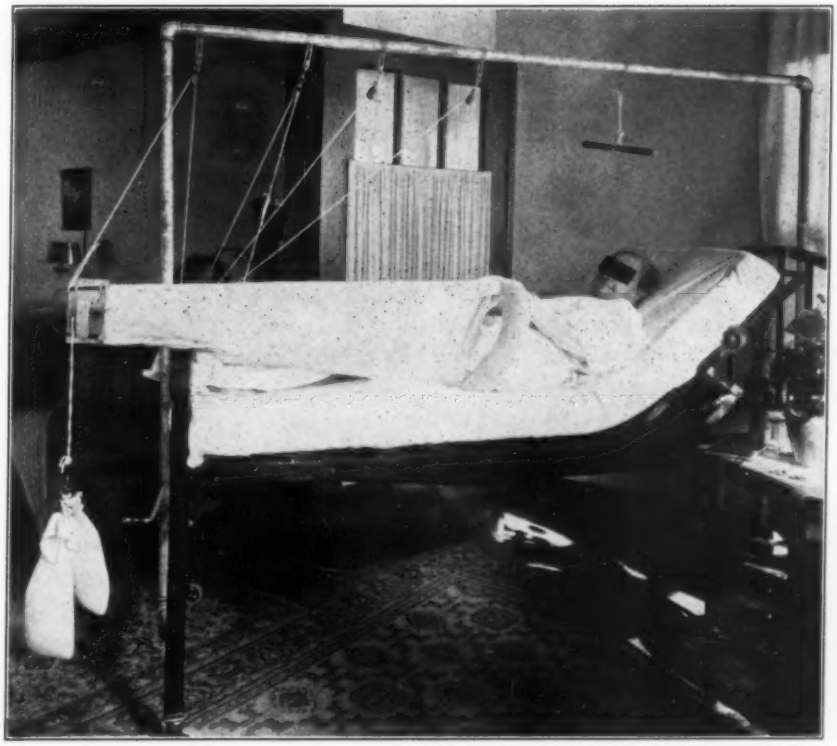

FIG. 4

Shows application of blocks, position of pulleys, method of traction, etc.

tion. The "hammock splint" as we term it, allows the leg to rest as if it were in a hammock, thus giving the patient a surprising degree of comfort. As previously stated, it is important that the ring of the Thomas splint be very materially enlarged, as otherwise the hammock effect which is so important cannot be obtained.

Summarizing the advantages of the splint:

First, the leg rests in a hammock with equal pressure along its full length.

Second, the splint is easily applied and seldom needs attention so far as adjustments are concerned.

Third, weight traction can be maintained at all times regardless of the position of the patient. We find this especially advantageous in cases of old or stout people, permitting attention to the back, et cetera.

Fourth, any amount of abduction can be obtained easily.

Fifth, rotation of the foot outward is impossible.

THE SKATE-SPLINT-CAST COMBINATION

BY R. M. YERGASON, M.D., F.A.C.S., HARTFORD, CONN.

In severe comminuted fractures of both bones of the leg, whether simple or compound, or where open operations may be required, the writer has found the combination of the skate, splint, and cast most effective.

The foot is wrapped thinly with sheet wadding and a fairly thick piece of felt placed about the heel and another over the instep. The skate[1] is then applied to the sole of the foot by means of plaster-of-Paris (Fig. 1)*. The supporting cross-bar of the skate is next attached so that it will assist in holding the foot when the splint is applied. The thigh and leg, to a point about four inches below the patella, next are bandaged with wadding; and a thick piece of felt is placed along the back of the thigh and popliteal space, as this will be the chief counterpoint for traction. Two thinner pieces of felt, long and narrow, are placed on either side of the thigh, and the splint, — which is exactly like a Thomas splint with the ring cut off, bent to an angle of about 135 degrees at the knee—is placed in position, the cross-bar of the skate resting upon it (Fig. 2).

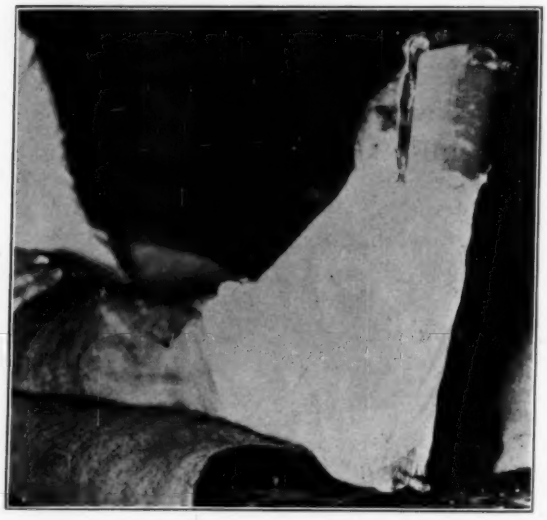

FIG. 1

The sole plate of the skate attached to the foot by plaster-of-Paris.

Next the thigh and splint are incorporated in plaster-of-Paris, a felt pad being placed about the patella. When the plaster is nearly completed, a turn of the plaster bandage should be taken around each one of the splint bars at the edge of the plaster near the knee, so as to make the splint perfectly solid in the plaster. This turn is illustrated in Figure 3, in which figure the edge of the felt about the patella may be seen below the edge of the plaster.

When the plaster is hard, anaesthetic can be

*In the presence of wounds on or near the foot the skate is attached by using pieces of gauze bandage pasted to the bare foot with celluloid. The celluloid solution consists of ordinary scrap celluloid dissolved in acetone to make a rather thick mucilaginous liquid. This is applied with a half-inch paint brush.

FIG. 2

Arrangement of the splint and padding before application of plaster to the thigh and knee.

given and the fracture manipulated. Whatever traction is necessary can be applied and, by means of the skate, the traction and the desired position of the foot is secured (Fig. 3). Hammocks of unbleached bandage, well padded, are placed to support the leg between the knee and ankle.

Should the post-setting x-ray prove unsatisfactory, and an open operation be decided upon, the preparation and the operation are done with the apparatus intact; when the fragments have been placed in the desired position, an assistant may clamp the skate so as to maintain them satisfactorily.

The site of the wound is not hidden by plaster-of-Paris, so it may be readily dressed and inspected. This is especially advantageous in compound fractures with the frequent inspection and lavage which such wounds require, as everything may be kept clean and neat and the position undisturbed. Minor changes in the position of the bones may be easily accomplished, if desired, by gently altering the position of the skate.

If plates or metal bands have been applied, as is sometimes necessary, they can be removed when union has taken place without disturbing the apparatus. Of course, when the union is firm enough, the whole apparatus is removed and a light splint substituted.

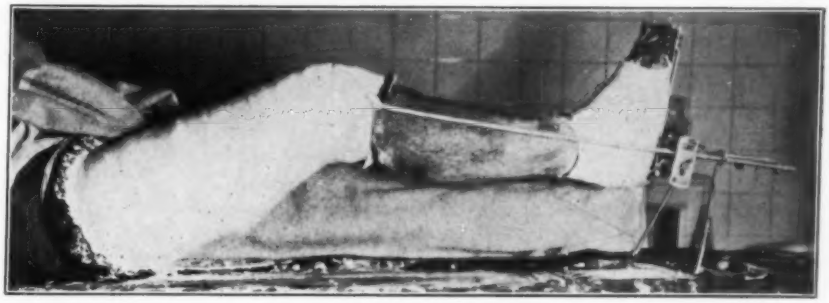

FIG. 3

The apparatus when completed except for the hammocks to support the leg where it is not included in the plaster.

There is one point about the preparation for open operation in cases where the wound is to be close to the ankle. The plaster about the foot should be sealed by painting it with celluloid solution.* Also the edge of the plaster should be sealed down upon the leg by first placing one layer of gauze bandage around the edge. The celluloid renders the whole thing water tight and its surface can be scrubbed as well as the leg, thus preventing contamination of the field of operation from the nearby plaster. The side bars of the splint, of course, must not be neglected in doing the preparation.

SUMMARY

1. A method of handling comminuted fractures of both bones of the leg by using the skate, the open splint, and the circular plaster-of-Paris in combination is described.

2. When doing an open operation on this type of fracture, it is most convenient to have the amount of traction and the position of the foot entirely under control. This is accomplished by the method outlined.

1. YERGASON, R. M.: The Skate in Fractures of the Lower Extremity. Surg. Gynec. Obstet., XXXVIII, 550, Apr. 1924.

*See Footnote, Page 658.

A. MACKENZIE FORBES

A. MACKENZIE FORBES

Dr. A. Mackenzie Forbes died suddenly on May 16, 1929. The passing of Dr. Forbes, although he had not been in good health for some time previously, came as a shock and grief to his many friends. Dr. Forbes was president of the American Orthopaedic Association last year and had a notable career.

He was the son of an old Montreal family, and was educated at the Montreal High School and at McGill University, graduating in medicine in 1898. Following post-graduate work in New York and abroad he returned to Montreal and was shortly after appointed to the Montreal General Hospital as Assistant in the Surgical Department. Early in his career he specialized in orthopaedic surgery and soon became prominent in that branch of medicine. From the beginning he conceived the idea of founding a children's hospital in Montreal, which would be especially devoted to children's surgery and orthopaedic surgery, and with it combine the services requisite to balance the work of such an institution.

From a modest beginning in a rented house on Guy Street his great conception grew and developed into wider scope as he interested certain benefactors in the work of the institution. Realizing the great gap in the advancement of disabled children, caused by

their loss of education, he founded the Cripples' School, in association with the hospital. This was the first school of its kind in Canada, and one of the best organized on the continent. In 1906 he was appointed Orthopaedic Surgeon to the Montreal General Hospital, Surgeon-in-chief to the Children's Memorial Hospital, and Director of the Cripples' School.

At the outbreak of the Great War he immediately volunteered his services and was sent to Valcartier Camp in 1914, to go overseas with the First Canadian Contingent. After a winter at Salisbury Plains he went to France as one of the surgeons of the First Canadian General Hospital. He continued his services until obliged to return to his duties in Montreal hospitals. His military service showed the same devotion to duty as his civil practice.

When the Shriners' movement for hospitals for crippled children was developed Dr. Forbes was named Surgeon-in-chief to the Shriners' Hospital in Montreal. This hospital is located directly east of the site of the Children's Memorial Hospital. Throughout his career Dr. Forbes displayed an enthusiasm for this work. Owing to the press of other duties, several years ago he was obliged to resign from the Montreal General Hospital.

As a monument to the personality, energy, and devotion to professional work of Dr. Forbes, stands the imposing hospital section on Cedar Avenue now working so effectively. It is not given to many men to see the accomplishment of an early ambition to benefit the public.

As a man, Dr. Forbes had the strong characteristics of his Highland ancestry: staunch in his purpose, a loyal friend and, despite his at times brusque manner, tender-hearted. It was a joy to be with him when making "rounds", to see the love and affection with which he was greeted by his children patients.

Professionally he stood very high among his fellows; alert, keen, and of an original mind not greatly hampered by tradition. In 1928 he was President of the American Orthopaedic Association, Clinical Professor of Orthopaedic Surgery at McGill University, and President of the Montreal Medical Society.

His passing will mean the absence of a marked personality to his colleagues and friends, and the loss of a great citizen to the community.

REGINALD HALL SAYRE

Reginald Hall Sayre died peacefully on May 29 of this year. Death came softly and gently as though it felt the serenity and kindliness of the life it was taking. He died in the full vigor of his strength, engaged almost to the end in the work which was the very breath of his nostrils.

By birth and training Reginald Sayre was an orthopaedic surgeon. He was born October 18, 1859, at 795 Broadway directly opposite Grace Church. His father, Lewis A. Sayre, whom we frequently hail the "Father of American Orthopaedic Surgery", had two older sons, Charles and Lewis, both destined to be orthopaedic surgeons, but such was the enthusiasm for orthopaedic surgery in the Sayre family that Reginald too, despite a temporary leaning toward law, had to follow the family tradition. During his boyhood at the Churchill and Maury school and Anthon's and during his college days at Columbia he showed a real love of scholarship, was elected to the Phi Beta Kappa, and took the highest honors in chemistry. Of a tall robust frame, he distinguished himself as a high jumper and as a champion in the mile walk, a track event which to his regret has now become obsolete. He had a strong literary flare, evidenced by his election as Editor of the Columbia Spectator. Friends who knew him then speak of his handsome presence, of the rare charm of his personality, his ease in conversation, his delightful humor,—traits which he carried with him through life.

In 1881 he entered Bellevue Medical College, and after his graduation served an internship at Bellevue Hospital. Here, despite his predilection for orthopaedic surgery, he worked on the Medical Service so as to acquire a thorough general training. From the hospital he went directly to his father's office. At that time Lewis Sayre was Professor of Orthopaedic Surgery at Bellevue Hospital Medical College. Reginald worked with his father until the latter died in 1900; then succeeded him as Professor of Orthopaedic Surgery at the Bellevue Medical College and held this position until 1929, when, just before his death, he was honored with the title of Professor Emeritus. He was Consulting Orthopaedic Surgeon to many hospitals, including St. Vincent's, Hackensack General, New York State Orthopaedic, Hospital for Joint Diseases, Montclair, Englewood, and Flushing Hospitals. He was a Charter Member of the American Orthopaedic Association, and attended its meetings with enthusiastic regularity. He was elected Vice-president of this Association in 1902 and President in 1903. For twelve years he was treasurer of the New York Academy of Medicine and for one year its Vice-president. The Orthopaedic Section of the Academy of Medicine acknowledged him the oldest and most regular member; scarcely a meeting passed that did not see him in his customary place. He was always most delightful in his discussions for he had a happy faculty of using homely expressions to describe obscure medical conditions. This gift gave a tang and humor to everything he said.

By nature and training he was an industrious student, and as he grew older gave increasingly of his time to his profession. Every morning, Sundays and holidays included, saw him making rounds on his children's ward at Bellevue Hospital. He lived his religion in his life with his patients, particularly with the poor and needy, and was at his best in his children's clinic. He was fond of all children but for his crippled children he had the warmest spot, and they knew it. They loved him and he them. When he died they wrote letters to his sister telling of this love. One crippled girl who had spent eight years in the hospital wrote that the time had not seemed hard or long to her because he had given her so much pleasure. The Social Service nurse in charge of the ward summarized the feelings of the children: "They feel that they have lost their best friend. 'All the doctors of the service are good to us', they say, 'but Dr. Sayre, he loved us'. He was never too busy to talk to them and most of all to listen to them."

REGINALD H. SAYRE

Despite his absorption in his work, he never failed to cultivate his many friends both in and out of the medical ranks. One of them, a member of our own Orthopaedic Association, Dr. Albert H. Freiberg, has beautifully expressed the feeling of friendship he bore Reginald Sayre: "During the many years of my membership in the American Orthopaedic Association and the opportunity this gave me to meet him year after year, I have known no one who commanded the affection and respect of its members equally with him. This was not only because of his great ability but also because of his innate kindliness of spirit and his unusual talent for friendship. A friend indeed he was to all of us." Dr. Sayre never married.

He had one great hobby,—a strange one for so peaceful a citizen—revolver shooting. This interest probably began shortly after his intern days when he enrolled as a private in Squadron A. (Eventually he became its lieutenant-colonel.) He soon discovered that he had a peculiar knack of hitting the bull's-eye with a revolver and he practiced with the pistol assiduously. He carried off numberless prizes, became the champion shot of the United States Revolver Association and represented America in the international contests held at London, Paris, and Stockholm.

An aristocrat to his finger tips, yet democrat enough to be a deep lover of all mankind; a scholar, yet gifted with the homely simplicity of the untutored; of ample means, yet never stressing wealth; a devoted physician giving daily to his patients of the best that was in him; a warm, true-hearted friend, generous, unselfish, modest; he typifies all that was best and noblest in his age and generation. We who come after him will revere his memory and strive to emulate his example.

News Notes

Dr. W. E. Gallie, of Toronto, has been appointed to the Chair of Surgery in the University of Toronto and Surgeon-in-chief at the Toronto General Hospital.

Dr. Charles F. Eikenbary and Dr. John F. LeCocq announce the opening of the Seattle Orthopaedic and Fracture Clinic, Summit Avenue at Madison Street, Seattle, Washington.

Dr. Samuel L. Robbins announces the opening of offices at The East 100th Street Medical Building, 2039 East 100th Street, Cleveland, Ohio.

Dr. D. E. Robertson has been appointed Surgeon-in-chief of the Hospital for Sick Children, Toronto.

Extensive preparations have been made for the **World Conference of Workers for Crippled Children,** to be held in Geneva, Switzerland, July 28 to August 2, in conjunction with the Third Biennial Session of the World Federation of Education Associations. Information may be secured from Paul H. King, Chairman of the Conference Committee, 428 Buhl Building, Detroit, Mich.

The *Journal* acknowledges receipt of The Scientific Basis of the Program and the Accomplishments of the National Tuberculosis Association, by Linsly R. Williams, M.D., issued by the **National Tuberculosis Association.**

This is a review of the activities for the cure, care, and prevention of tuberculosis during the last twenty-five years. The opening paragraphs give a review of the knowledge already gained concerning the disease itself. This is followed by a statement as to the program of the Association during the early years of its work and the development of that work during the succeeding years. The closing section of the article gives some of the results of the program and some of the plans for the future work of the Association.

An interesting account has been received of the laying of the foundation stone of the extension of **Bai Yamunabai L. Nair Charitable Hospital,** Bombay, on March 19, by Governor Sykes. The event proved to be an occasion for the expression of appreciation from Government and from the people of Bombay of the valuable service rendered by this institution, as well as to Dr. L. Nair, whose effort and generosity have helped to make the work possible. Congratulations are due this institution for the increased opportunity for service which these enlarged facilities will make possible.

With the constantly increasing perfection of the x-ray, and with the added necessary power from universal use, there has come a demand for added safety from some of the distressing occurrences accompanying its use. That the need of this has now been realized is shown in the development of an efficient shock-proof apparatus to meet the demands for such safety. Many efforts to accomplish this have been made during the past few years. It is of interest to those obliged to depend so largely on the x-ray that the progressive experimentors have finally brought this to an actual fact, and that this difficulty in the future will undoubtedly be avoided.

At the meeting of the Executive Committee of the **British Orthopaedic Association,** held in December, the following were elected *Associate Members:*

F. G. Allan, 3 Calthorpe Road, Five Ways, Birmingham.
R. Broomhead, Leeds General Infirmary, Leeds.

At the meeting held on May 3, the following members were elected:

Miss Vera Veitch, *Full Member,*
Cripple Children's Hospital, Stoke-on-Trent.
Howard L. Crockatt, *Associate Member,*
Children's Orthopaedic Hospital, Kirby Moorside, Yorks.
H. J. Maister, *Associate Member,*
Royal Cripples' Hospital, Birmingham.

The Robert Jones Medal and Association Prize for 1928 has been awarded to Mr. E. P. Brockman for his essay on Club-Foot (Congenital Talipes Equinovarus).

The Bi-annual Joint Meeting of the **Northern and Southern California Orthopaedic Clubs** was held in Los Angeles, May 4. Dr. Dunlop and Dr. Gallant gave an end-result clinic in the morning at the General Hospital, covering a very large field of bone surgery.

In the afternoon the following program was presented at the Orthopaedic Hospital School:

Bone Block Stabilization and Transplant of Biceps to Patella.
DR. LOWMAN

Myasthenia and Progressive Muscular Dystrophy.
DR. WRIGHT

Congenital Dislocation of Hip and Non-union of Radius.
DRS. REED AND SCHOTT

Speech Defects, with Motion Picture Demonstration.
DR. STIVERS

A Rest for Maintaining Position During Hip Operation.
Instrument for Distracting Bone Ends for Insertion of Intermedullary Peg Grafts.
Celluloid Walking Inside-shoe Slipper for Maintenance of Corrected Club-foot.
DR. PATTON

Preliminary Report on Use of Irradiated Ergosterol in Bone and Joint Tuberculosis.
DR. BROCKWAY

Successful Bone Graft in Congenital Fracture of Both Bones of the Leg.
Presentation of case of Double Congenital Dislocation of Hip, showing spontaneous formation of well placed and good functional acetabulum on one side.
Muscle Transplant for Trapezius Paralysis. Exhibition of an inexpensive and efficient bed frame for hyperextension.
DR. BARNARD

During the last few years there has been organized an **International Committee for the Study and Prevention of Rheumatism.** Committees have been organized in different countries and efforts made in certain instances to interest the government, and in others large industrial concerns and insurance companies. It has been shown that the disability due to rheumatism is great in all countries.

The movement has recently undergone a reorganization, and is now called the "International League for the Control of Rheumatism." A Committee has been formed for the United States and Canada, of which Dr. Ralph Pemberton of Philadelphia is Chairman, and of which the following men are members: Dr. Robert B. Osgood, Boston; Dr. C. C. Bass, New Orleans; Dr. Rea Smith, Los Angeles; Dr. Hans Zinsser, Boston; Dr. A. A. Fletcher, Toronto; Dr. Lewellys F. Barker, Baltimore; Dr. Russell L. Cecil, New York City; Dr. Archer O'Reilly, St. Louis; Dr. Joseph L. Miller, Chicago; Dr. Russell L. Haden, Kansas City; Dr. George C. Griffith, Philadelphia; and Dr.

Melvin S. Henderson, Rochester, Minnesota. There have thus far been two meetings of this American Committee, the first on March 17, 1928, in Philadelphia and the second, October 13, 1928, in Boston. Two delegates were elected at the meeting in October to represent the American Committee at the International meetings: Dr. Ralph Pemberton of Philadelphia, and Dr. A. A. Fletcher of Toronto as alternate.

A meeting of the **Boston Orthopaedic Club** was held on the evening of March 11, 1929, at the Deaconess Hospital. Three interesting papers were presented: Dr.Howard F. Root, on the general aspects of diabetic problems; Dr. Mark H. Rogers, on lesions of the shoulder joint, which he characterized as chronic subdeltoid bursitis, and secondly, diabetic neuritis involving the legs; Dr. Leland S. McKittrick, on the surgical aspects of diabetes, particularly with relation to gangrene.

The meeting of the Boston Orthopaedic Club on Monday evening, April 15, 1929, was held in the Amphitheatre of the Old Surgical Building at the Boston City Hospital. The following presented cases:

Dr. Otto Hermann—Septic compound fractures.

Dr. J. H. Shortell—Fractured spine with laminectomy, showing partial recovery.

Dr. J. H. Burnett—Fractured shoulders.

Dr. Richard Berg—Fractures of the humerus; treatment with Peckham splint followed by a plaster spica.

Dr. F. J. Cotton—Spontaneous fractures; discussion of calcification of bones and types of ankle fractures.

At the meeting of the Boston Orthopaedic Club in Sprague Hall of the Boston Medical Library on Monday evening, May 6, 1929, Dr. Nathaniel Allison and Dr. R. K. Ghormley presented a series of lantern slides illustrating various types of joint changes in arthritis and tuberculosis.

The first triennial Listerian Oration under the auspices of the **Manitoba Medical Association** was delivered by Dr. H. P. H. Galloway at a dinner held in honor of Lord Lister's birthday, in the Fort Garry Hotel, Winnipeg, April 8, 1929. The President, Dr. E. J. Boardman, occupied the chair, and the speaker of the evening was introduced by Dr. B. J. Branson, Professor of Surgery, Faculty of Medicine, University of Manitoba.

Dr. Galloway chose as his subject, "A Review of Some of the Advances in Orthopaedic Methods of Treatment made possible by Listerism". He was able to describe from personal recollection how these cases were managed by splints and appliances and manual manipulation, between thirty and forty years ago, and to trace the gradual evolution of Orthopaedic Surgery that has taken place in the intervening years. Tuberculosis of bones and joints, congenital dislocation of the hip in children and adults, recurrent dislocation of the shoulder, chronic arthritis and fractures, the speaker said, are handled much more effectively now, since antiseptic and aseptic surgery have made operative treatment possible. The more recent approved operations for many of these conditions were described in detail.

The closing paragraphs of the oration do not admit of a summary, and are given below verbatim:

"Instead of exhausting the list of triumphs which Lister's discovery made possible in the orthopaedic field I have merely touched the fringe of the subject. Enough has been said, however, to bring once more to our remembrance the fact that Surgery must forever owe to the genius, the vision, the faith and the tireless industry of our great Lister a debt that is not merely vast but infinite.

"Where is there a surgeon who, could such a choice be given him, would not rather have been Lister than Shakespeare? Where is there a surgeon who does not think of Lister as an outstanding figure in that small circle of great medical benefactors whose combined achievements have brought to suffering humanity comfort of body comparable to the comfort of soul made available to our race by a certain Nazarene?

"No one would question that Lister was a man of clean hands figuratively as well as literally. No one doubts that his character was above reproach,—that in the widest sense, he was a man of pure heart. No one could imagine that simple, dignified, sincere nature tarnished by anything so foreign as vanity. No one could look upon that frank, noble countenance and think it possible that such a man could be guilty of falsehood, misrepresentation or deceit; and it does not strain the imagination to suggest that in uncovering the dark secrets of wound infection Lister mounted to a divine height and became an agent of the Almighty. Therefore I would choose, as a kind of dedicatory inscription to my address, words from the twenty-fourth Psalm, which I shall allow my fancy to regard as having a prophetic application to this great soul; 'Who shall ascend into the hill of the Lord? or who shall stand in his holy place? He that hath clean hands and a pure heart; who hath not lifted up his soul unto vanity, or sworn deceitfully'.

'Nothing can cover his high fame but Heaven;
No pyramids set off his memories,
But the eternal substance of his greatness,—
To which I leave him.'"

At the suggestion of the **Interurban Orthopaedic Club**, Dr. Willis Campbell kindly consented to arrange a demonstration and clinic. Consequently the Club meeting for the spring of 1929 was held in Memphis on March 29 and 30, with the President, Dr. John L. Porter, presiding.

The following program was presented:

FRIDAY, MARCH 29

Morning Session

Bone Tumors.

DR. C. R. ROUNTREE AND DR. J. F. HAMILTON

Spinal Cord Lesions.

DR. R. E. SEMMES

Arthroplasties.

DR. WILLIS C. CAMPBELL

Bone Graft and Epiphyseal Separation.

DR. J. S. SPEED

Motion Picture Reels Illustrating Operative Technique.

DR. JOS. I. MITCHELL

Afternoon Session

Operative Clinic at Baptist Memorial Hospital.

SATURDAY, MARCH 30

Morning Session

Demonstration of Splints and Special Apparatus.

DR. JOS. I. MITCHELL AND DR. B. T. WRIGHT

Synovectomies.

DR. J. S. SPEED

Biopsies.

DR. J. F. HAMILTON

Drop-foot.

DR. WILLIS C. CAMPBELL

Transference of the Crest of the Ilium.

DR. C. R. ROUNTREE

Fusion of Spine; Fusion of Sacro-iliac.

DR. JOS. I. MITCHELL

Fusion of Hip. Fusion of Ankle.

DR. WILLIS C. CAMPBELL

Dislocation of Acromioclavicular Joints.

DR. J. S. SPEED

Afternoon Session

Inspection of Crippled Children's Hospital and Operative Clinic at the Hospital for Crippled Adults.

It was voted that the next meeting of the Club should be held in New York in the autumn of 1929. The Club is very grateful to Dr. Willis Campbell and his associates for the most interesting work that was shown, and for the hospitality extended to members of the Club.

AN ANATOMICAL EXPEDITION TO AFRICA

An announcement of importance to physical anthropologists, anatomists, and orthopaedic surgeons, has recently been made by President Nicholas Murray Butler, concerning an African Expedition. It has been financed by Columbia University and represents the joint activity of the Department of Anatomy of the College of Physicians and Surgeons (Columbia University) and of the Department of Human and Comparative Anatomy of the American Museum of Natural History.

The chief purposes of the Expedition are: (1) to procure adult specimens of gorillas, chimpanzees, and other African primates which will be embalmed and prepared in the field for anatomical study in this country; and (2) to obtain motion pictures and other records of postural and foot conditions among the natives for comparative study with corresponding conditions prevailing among peoples subject to the artificialities imposed by our more highly developed state of civilization.

The enterprise was instigated and planned by Prof. Dudley J. Morton of the Department of Anatomy of the College of Physicians and Surgeons, whose work combines physical anthropology with the study of body mechanics as they pertain to orthopaedic surgery. Prof. S. R. Detwiler, head of the Department, has most actively supported and helped advance the project throughout its development.

Upon invitation, the American Museum of Natural History entered enthusiastically into the plans and will share in the material obtained. Their cooperation in assigning Mr. Henry C. Raven, an experienced field man and scientist to serve as leader of the expedition, and Prof. William K. Gregory, Curator of the Department of Human and Comparative Anatomy, to collaborate with the University representatives, Prof. J. Howard McGregor, of the Department of Zoology, and Prof. Earle T. Engle of the Department of Anatomy, contributes toward making the expedition one of the outstanding scientific events of the year.

The Advisory Committee comprises the following members: President Nicholas Murray Butler, chairman ex-officio; Dr. William Darrach, Dean of the College of Physicians and Surgeons; Frank D. Fackenthal, Secretary of Columbia; Prof. Henry Fairfield Osborn, President of the American Museum of Natural History; and George H. Sherwood, Director of the Museum.

The committee in immediate charge of the expedition and its related activities consists of Dr. Dudley J. Morton, Associate Professor of Anatomy, chairman; the four members forming the personnel of the expedition; and Prof. Samuel R. Detwiler and Prof. Philip E. Smith of the Department of Anatomy.

The expedition left New York, May 29 on the Aquitania. The African trip will start from the eastern coast at Dar-es-Salaam, proceeding first into the Belgian Congo for specimens and studies of the mountain gorilla (Gorilla beringei) in the region of the Parc d'Albert Nationale. From there the journey will move toward one of the tributaries of the Congo River and continue across to the west coast where, in French Territorial Africa, specimens of the lowland gorilla will be sought. Studies of the natives will be made throughout the trip, and chimpanzees and lower primates collected wherever available. The expedition is expected to return to this country early next year.

Acknowledgment is made of the interested cooperation of Prof. John C. Merriam, President of the Carnegie Institute (Washington), and of Mrs. Carl Akeley, in sponsoring the purposes of the expedition, and in contributing commendatory representations to the Belgian and French Governments for necessary permits.

Current Literature

CHIRURGIE DE L'ARTICULATION TEMPORO-MAXILLAIRE. By L. Dufourmentel. *Paris, Masson et Cie*, 1929, 40 fr.

The author describes what may be termed the geometric anatomy of this joint, the character of the motion of which has no parallel, and is most important in its bearing on some of the pathological conditions which are met with in the treatment of this articulation. The interest in this joint is necessarily shared between the surgeon and the dentist, but the surgical affections and the surgical treatment of this articulation are becoming more and more prominent and more important. In this book particular attention is given to those affections which are distinctly surgical in character.

The subject is discussed in eight divisions:

I. L'Articulation temporo-maxillaire.
II. Les Arthrites temporo-maxillaires.
III. Le Trismus.
IV. Les Déviations mandibulaires d'origine articulaire.
V. Le Prognathisme.
VI. Les Luxations temporo-maxillaires.
VII. Les Ankyloses temporo-maxillaires.
VIII. Les Fractures articulaires.

The three important conditions receive the larger part of attention in this book,—the arthritides, the luxations, and ankylosis. Practically all other involvements are discussed, and each is considered as to the etiology, pathology, and diagnosis with the treatment. An important portion of the book, also, is devoted to the treatment of deformities of the jaw and other surgical treatment. One particular chapter (Le Prognathisme) is most valuable because of the thoroughness with which these distressing conditions are treated.

The common and distressing affection, attended with the cracking of the joint, particularly in mastication, either associated with frequent mild luxation or not, is one of the distressing conditions which so often confront the practitioner as well as the surgeon, and too little is known of the mechanism and pathology of its production. This has been clearly discussed in this book, the various forms differentiated with the mechanism of the occurrence illustrated, and the cases cited in which operation is to be considered.

It is seldom that so much time and study are devoted to one articulation, but the peculiarity of this joint, combined with its importance, fully warrants the devotion which the author has given to this subject and will fully repay the surgeon, as well as the dentist, who devotes his time to a study of this book.

THE MOBILIZATION OF ANKYLOSED JOINTS BY ARTHROPLASTY. By W. Russell MacAusland and Andrew R. MacAusland. Philadelphia, Lea & Febiger, 1929, $4.00.

A monograph of 252 pages with 154 illustrations. The subject matter is taken up under four headings.

Part I discusses types, etiology, pathology, diagnosis and treatment of ankylosis. The "functional position" of various joints is carefully considered and properly emphasized. The position given for the shoulder, "45 degrees-50 degrees abduction, 5-10 degrees forward of the saggital line" is not quite clear.

Part II defines arthroplasty and gives a review of methods employed by the more notable surgeons in this particular field. Indications and contraindications to arthroplasty are taken up and factors relating to a good result are discussed. The ultimate fate of the interposed fascia and experimental arthroplasty are considered.

Part III—"Arthroplasty of Specific Joints"—gives the authors' operative technique, after-treatment, and résumé of the literature of all joints, in which the method is considered applicable by the writers.

Part IV—"The Prevention or *Minimization* of Ankylosis"—is brief and of questionable value if the book is intended as a reference text for arthroplasty. It contains much that is pertinent, however, and might well be incorporated in a work of this sort.

The general index and bibliographies indicate a careful survey of the field covered. Many of the illustrations and case records are not entirely clear.

The authors very properly leave the impression that arthroplasty is a highly technical operation, to be undertaken after careful consideration of all details and then only by those qualified through experience and operative skill.

KONSERVATIVE FRAKTURENBEHANDLUNG. By Dr. Leopold Schönbauer. Vienna. Julius Springer. 1928.

Schönbauer's small volume on the conservative treatment of fractures can hardly be classed with the standard textbooks. Indeed, as Eiselsberg comments in his preface, one might question the propriety of adding another textbook to the large number of excellent volumes that present this subject to us. And yet this compact presentation justifies its place on our book shelves.

Primarily a study of the fractures treated in Eiselsberg's clinic in Vienna over a period of more than fifteen years, the publication covers the subject in a logical and comprehensive manner. The broader aspects of fractures in general, including the methods of diagnosis, the secondary complications, the physiological and pathological processes of repair, the principles of treatment, and the after-care, pave the way for the specific consideration of various fractures.

The consideration accorded the fracture of any bone is never excessively long. As a rule, the statistics found in Eiselsberg's clinic, are quoted and while the generally accepted methods of treatment are presented, the specific methods used in this clinic are clearly laid out. A rather complete bibliography that is appended helps make this volume an excellent monograph.

ARTHRITIS AND RHEUMATOID CONDITIONS: THEIR NATURE AND TREATMENT. By Ralph Pemberton. Philadelphia, Lea & Febiger, 1929. $5.00.

It is of unusual value to have a work such as this volume of Dr. Pemberton's, which has been written by one who has devoted his time so exclusively to a study of a subject, and particularly of one which needs so much clarifying as that of arthritis. An affection which has for centuries so baffled the profession, both in the understanding of its etiology and the treatment of its very varied manifestations, has naturally gathered to itself a vast deal of theory and an immense list of therapeutics; and as many of these have proved themselves to be inefficient, general skepticism has naturally resulted, not only in regard to the value of treatment, but also in regard to the understanding of the abstract principles both of the study and of the treatment of this affection.

Dr. Pemberton, in his work, has been able to gather and put in a rather concise form much of the history which has grouped itself about this disease, and to eliminate to a very large extent the irrelevant theories which have so long held sway. It is by this sensible view of this difficult subject that the profession at large may be tempted to consider these affections from the same point of view as other diseases.

He has discussed the different theories of the etiology, particularly that of the infections, focal and general, and the part they play alone and in combination with other general conditions which influence their action. He also discusses the difficult subject of

classification, tending toward eliminating many classifications which are more or less fanciful, classification which cannot be regarded in itself as an important department in the study of this disease and is necessary only as a means or a method for record and a way of grouping the treatment of the very many manifestations. The author has taken up very thoroughly the different therapeutic methods for treatment of various types of arthritic joints, and has discussed in detail and has given directions for the use of physiotherapeutic measures which have been used so freely, many times unwisely, and still more frequently uselessly. He lays great emphasis on the value of physiotherapy when properly used.

A very small portion of the book is devoted to the surgical treatment. This seems wise, for it must be acknowledged that surgical treatment of the late arthritic conditions should be employed with the utmost caution, and only by those who have had a large experience with them and with joints in general, and who realize the necessity of long and careful after-care.

PHYSIO-THERAPY IN GENERAL PRACTICE. By E. Bellis Clayton, M.B., B.Ch., Ed. 2, New York, William Wood & Co., 1928. $3.50.

The book "Physio-Therapy in General Practice", by E. Bellis Clayton, Director of the Physio-Therapeutic Department at King's College Hospital, London, is an excellent textbook for students of physiotherapy and would prove to be a useful reference book on the subject.

The first part of the text gives a description of the different forms of manipulation for both muscles and joints. This is followed by a description of exercises for general physical development. Chapter II gives an outline of the faradic, galvanic, and sinusoidal currents, diathermy, high-frequency, ultraviolet ray, and radiant heat. Chapter III takes up injuries to nerves, muscles, tendons, and their treatment. Chapter IV covers the treatment of fractures in general, while Chapter V describes the different types of fractures. Chapter VI opens with a description of flat-foot, and goes on to describe other deformities of the foot and their treatment by physiotherapy. Chapter VII discusses heart disease and gives the treatment by exercise for heart conditions and other local disturbances. Chapter VIII deals with respiratory disease and exercise treatment. Chapter IX gives an outline of abdominal treatment. Chapter X takes up arthritis in its different forms. Chapters XI, XII, and XIII discuss various nerve conditions, both upper and neuron lesion types of paralysis. Their individual treatment by physiotherapy is well covered. The end of the book has some good illustrations of crawling exercises, and the appendix tabulates certain gymnastic terms and illustrates the same.

The various branches are clearly described and the text itself is well organized, although pictures, illustrations, and drawings are rather sparsely distributed throughout the book.

THE VERTEBRAE. ANNALS OF ROENTGENOLOGY, Vol. VIII. By Arial Wellington George and Ralph Davis Leonard. New York, Paul B. Hoeber, Inc., 1929. $10.00.

The work of Drs. George and Leonard is confined to a consideration of the x-ray evidences of the various affections of the spinal column, and it has the great advantage in a work limited in its scope that the details can be more thoroughly treated. It is particularly valuable at this time when there is being made the finer differentiation of different pathological conditions occurring in the spine, and when an increasing interest is given to these affections, particularly stimulated by the growing importance of industrial surgery and the demands made by the Workingmen's Compensation Act.

In the beginning the authors give a chapter to the technique of taking the x-rays, as well as instructions to be followed in their interpretation, and the significance of many of the findings. Illustrations are remarkably clear,—in fact, are so well reproduced that the student will frequently find difficulty in using these illustrations as a model when finding these changes in the usual x-rays which come to his hand. The work is ingen-

iously divided into two parts, the first comprising the consideration of the pathological conditions resulting in the destruction of bone, and the second, of those conditions resulting in the reproduction of bone,—osteomyelitis, etc. The second part is devoted to a sectional study of the spinal column, the cervical, dorsal, lumbar, lumbosacral, and sacral areas in turn being considered. There is necessarily so much overlapping in such a subject between the pathological and anatomical divisions, it is always a question of which is the better method of presentation. It would seem, however, that in this work the authors have chosen a particularly valuable method, for it allows a consideration of the anatomical and pathological characteristics peculiar to each region of the spine. The part devoted to fractures and dislocations will be found of particular value, both in the description of the condition and in the x-rays, and also in showing the late changes which develop after these special injuries. Several portions have been contributed by other authors especially qualified to present the subject assigned to them.

In the description of roentgenograms the authors frequently include brief résumés of clinical and etiological factors of the diseases. Since many of these clinical factors are still in the field of dispute, and such a brief portion of these difficult questions can be presented in a work of this kind, it would seem that a book on a subject so specialized as is roentgenology would be more consistent if confined to its one special department. The book will be found of distinct value in a study of this important subject.

The *Journal* acknowledges receipt of the bound articles written by the members of the Orthopaedic Staff of the Massachusetts General Hospital during the past five years. The subjects include the most important problems met with in an orthopaedic clinic, and the work shows the value of concentration of effort by special detail, for the purpose of developing information, and perfecting methods of diagnosis and treatment.

The *Journal* acknowledges the receipt of the Silver Jubilee Number of *The Antiseptic* (Vol. XXVI, No. 4, April 1929), published in Madras. This journal was founded twenty-five years ago by the late Dr. T. M. Nair. Both Dr. Nair and Dr. U. Rama Rau, the present editor, have made persistent and commendable efforts toward the improvement of the standards of the practice of medicine in their country. It is necessary to recognize the difficulty that surrounds such a pioneer effort, and they are to be congratulated on the results of their endeavor. The journal contains, in addition to many excellent papers, very many letters of congratulation and expressions of good will from medical men of prominence in very many countries.

The *Journal* wishes to acknowledge the receipt of the following books sent to the Editorial Department:

L'Enseignement Médical en France: A l'Usage des Médecins et Étudiants Français ou Étrangers. Edited by La Presse Médicale and L'Association pour le Développement des Relations Médicales. Paris, Masson et Cie, 1929.

Giornale Medico dell'Ospedale Civile di Venezia. Venezia, Vol. II, No. 5, November 1928; Vol. III, Nos. 1 and 2, February and April 1929.

Upsala Läkareförenings Förhandlingar. Stockholm, Vol. XXXIV, Häft. 3–4, 1928–1929.

The Johns Hopkins University Circular: School of Hygiene and Public Health. Catalogue and Announcement for 1929–1930. Baltimore, No. 4, April 1929.

Thirty-Fourth Report of Progress in Orthopaedic Surgery. Reprinted from the Archives of Surgery, Vol. 16, Part I, pp. 153–168, January 1928, and pp. 615–630, February 1928.

Thirty-Fifth Report of Progress in Orthopaedic Surgery. Reprinted from the Archives of Surgery, Vol. 16, pp. 1112–1126, May 1928, and Vol. 16, pp. 1266–1278, June 1928.

Thirty-Sixth Report of Progress in Orthopaedic Surgery. Reprinted from the Archives of Surgery, Vol. 17, pp. 521–534, September 1928, and Vol. 17, pp. 689–714, October 1928.

The Thirty-Seventh Report of Progress in Orthopaedic Surgery. Reprinted from the Archives of Surgery, Vol. 18, Part I, pp. 163–178, January 1929, and Vol. 18, pp. 755–768, February 1929.

Slovanský Sborník Ortopedický. Brno, Czecho-Slovakia, Vol. III, No. 3, 1928; Vol. IV, No. 2, 1929.

Policlinica. Valencia, Vol. XII, Fasciculo VII, Num. 139, April 10, 1929.

EINIGE ORTHÖPADISCHE MITTEILUNGEN (Some Orthopaedic Communications). Nils Silfverskiöld. *Acta Chir. Scandinavica*, LXIV, 294, 1928.

Five orthopaedic conditions are discussed. Recurrent dislocation of the patella is studied with axial roentgenograms which show the infrapatellar space of the flexed knee. The occurrence of bipartite patella and loose bodies is so demonstrated. In performing the Krogius operation, the writer transplants the capsular bridge from the medial to the lateral side of the patella while the knee is flexed to forty-five degrees. In this way the reenforced capsule is not an obstruction to bending.

In paralytic deformities of the hand where opposition of the thumb is lost but power is retained in the flexor pollicis longus, excellent function is obtained by transplanting this muscle. The tendon is divided at the metacarpophalangeal joint and the proximal end of the distal portion anchored to the radial sesamoid. The proximal part is passed under the abductor pollicis brevis and the superficial head of the flexor pollicis brevis. It is attached to the insertion of the opponens pollicis, which muscle it replaces.

The deformity following ulnar paralysis is lessened by transplanting the sublimis tendons of the fourth and fifth digits to the dorsal aponeurosis just distal to the metacarpophalangeal articulation.

Arthrodesis of the shoulder joint is indicated in cases of residual poliomyelitic paralysis so long as the hand can be made prehensile and both clavicular joints are mobile, even when the elbow is flail and must be ankylosed.

In a case of traumatic medial displacement of the extensor tendon of the left middle finger, replacement of the tendon and splinting of the finger for three weeks were followed by a return of the normal function. No operation was necessary.—*W. P. Blount, M.D., Milwaukee, Wis.*

TWO CASES OF GANGLION ORIGINATING FROM THE INTERNAL MENISCUS OF THE KNEE. Nils Silfverskiöld. *Acta Chir. Scandinavica*, LXIV, 548, 1928.

The medial semilunar cartilage is much less frequently involved in a cystic process than the lateral. Two such cases are reported. In each the sartorius slipped over the mass with a jerk on movement of the knee. One cartilage was removed with the mass, and the tissue examined microscopically. Connective tissue had undergone myxomatous degeneration and cyst formation.—*W. P. Blount, M.D., Milwaukee, Wis.*

ÜBER SOG. CHONDROMATOSE DER GELENKKAPSEL (CONCERNING THE SO CALLED CHONDROMATOSIS OF THE JOINT CAPSULE). T. Beckman and Gunhild Ivarsson. *Acta Chir. Scandinavica*, LXIII, 551, 1928.

A case of bilateral chondromatosis of the knees in a woman of fifty is presented clinically by the first writer. Swelling and limitation of motion developed over a period of years without recognized trauma. Roentgen-ray examination showed many partly calcified loose bodies in the right and a few in the left knee. Other joints were unchanged. Synovectomy and removal of forty bodies on the right was followed by the return of good function.

A review of the available fifty-five cases in the literature establishes a variable clinical picture in the condition. Trauma and infection must be considered as possible etiologic factors.

The pathologic study by Ivarsson supports the conclusion that chondromatosis is not a true tumor, but is allied to arthritis deformans. There is in both a tendency to the formation of cartilage and new bone. The clinical differentiation should be made, however, because of the difference in prognosis.—*W. P. Blount, M.D., Milwaukee, Wis.*

OSSIFICATIONS OF THE COSTAL CARTILAGES: THEIR RELATION TO HABITUS AND DISEASE. Frank Riebel. *Am. J. Roentgenol.*, XXI, 44, Jan. 1929.

This is a very interesting paper, of which the following summary is given:

"The ossification in the costal cartilages in 541 cases was analyzed, and correlated with the incidence of tuberculosis, syphilis, and habitus. The findings of Rist, Gally, and Trocme that the ossification proceeds more rapidly in the male were corroborated. No relationship with tuberculosis, either as an etiological factor or as a result, could be discerned; this is contrary to the findings of certain German authors, who consider early ossification as a cause of tuberculosis and also as a character of favorable prognostic import.

"No relationship to habitus was discovered."—*Edward S. Hatch, M.D., New Orleans, La.*

BONE LESIONS IN SARCOID: A ROENTGEN AND CLINICAL STUDY. Howard P. Doub and Frank R. Menagh. *Am. J. Roentgenol.*, XXI, 149, Feb. 1929.

The authors have written this paper to show, as they say, these marked changes in osseous system as they have been very markedly emphasized in the roentgen literature. Two cases are reported in which the histological and pathological work is carefully described. Bone changes are shown to consist of a slowly progressive alteration in the trabecular formation of the bone followed by actual bone destruction. There are several types of bone involvement. In one, there is an alteration of trabecular structure; in another, the lesions are punched out areas of bone destruction in the phalanges. The metacarpals and metatarsals may show lesions. The progress is very slow, one of their cases being under observation for two and one-half years. The authors feel that these lesions apparently are an atypical formation of tuberculosis which may or may not have skin manifestation.—*Edward S. Hatch, M.D., New Orleans, La.*

A CONTRIBUTION TO THE MECHANISM OF FRACTURES AND DISLOCATIONS IN THE ELBOW REGION. T. Turner Thomas. *Ann. Surg.*, LXXXIX, 108, Jan. 1929.

This is an attempt to explain the lines of force producing the more common fractures and dislocations about the elbow. The author's conclusions were reached after a study of experimentally produced fracture upon the cadaver, and a close study of radiograms. Definite statements of the exact method of production of fractures and dislocations are difficult to make—"Few who fall are able to describe the circumstances of the fall" Variations in anatomical structure and force of muscle pulls also complicate the subject.—*Fred G. Hodgson, M.D., Atlanta, Ga.*

THE EFFECT OF BONE TRANSPLANATION ON THE BLOOD CALCIUM LEVEL. George Halperin and E. L. Walsh. *Arch. Surg.*, XVIII, 819, Mar. 1929.

In an effort to substantiate the reported rise of blood calcium in animals in whom bone transplants have been done, Halperin and Walsh made studies on three dogs and three rabbits. Assuming that "utmost accuracy and prolonged observation were more important than the number of animals", the authors made weekly blood examinations for at least four weeks. Their findings lead them to conclude that no real rise in the blood calcium level follows a homogeneous bone transplant.—*I. Wm. Nachlas, M.D. Baltimore, Md.*

SYNOVECTOMY IN CHRONIC ARTHRITIS. Nathaniel Allison and G. Kenneth Coonse. *Arch. Surg.*, XVIII, 824, Mar. 1929.

Synovectomy is offered as an operation of distinct value in the treatment of those cases of arthritis deformans characterized by signs of subacute synovitis, local tender-

ness, stiffness and pain on movement of the joint, increase in synovial fluid, and thickening of the synovial membrane. In acute synovitis of gonorrheal and pyogenic origin this operation is contraindicated. Experience with fifty synovectomies leads the authors to conclude that relief of pain can be almost universally obtained. Good motion is said to follow in a large percentage of cases. The operation frequently produces a marked improvement in the general arthritic process.

The presentation of the history of the operative procedure, a survey of the physiology and pathology of the synovial membrane and fluid, and a simple technique for operation on the knee make the article a well rounded paper.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

CUSHING BIRTHDAY VOLUME. *Arch. Surg.*, XVIII, No. 4, Apr. 1929.

Dedicated "To Harvey Cushing, Master Surgeon and Teacher" on his sixtieth birthday, the collection of articles that forms the Birthday Volume is not only a tribute to the man but a genuine gift to the medical profession. Cushing's "pupils", the writers of these articles, include many of the directors of surgical progress of the day. The papers presented in the volume are indicative of the high plane of the work they do.

Though the material presented is not limited to orthopaedic surgery, quite a few articles of orthopaedic interest are included. Heuer's essay on "The So Called Hourglass Tumors of the Spine" begins the series of papers, which includes a treatise on the histologic changes in hyaline cartilage in traumatic arthritis by Smith-Petersen, a study on scoliosis by Brewster, a scholarly report on the tonus and contracture of skeletal muscles by Frédéric Bremer, and several other presentations of particular interest to orthopaedic surgeons. There is, in addition, in the 2045 pages of this book, much of general surgical interest to make it well worth perusing.—*I. Wm. Nachlas, M.D., Baltimore, Md.*

THE DEVELOPMENT OF CYSTS IN CONNECTION WITH THE SEMILUNAR CARTILAGES. Robert Ollerenshaw. *British J. Surg.*, XVI, No. 64, 555, Apr. 1929.

Fourteen cases of cysts of the external semilunar cartilage and four of cysts of the internal cartilage are reported. The condition is primary in the cartilage and usually follows a definite injury. An endothelial type of cell lines the cyst or cysts. The writer believes they are of developmental origin. All of the patients have fully recovered after complete removal of the cyst and cartilage.

DEFORMITIES OF THE LUMBOSACRAL REGION OF THE SPINE. James F. Brailsford. *British J. Surg.*, XVI, No. 64, 562, Apr. 1929.

This paper was awarded the Robert Jones Gold Medal and Prize of the British Orthopaedic Association for 1927. The subject matter is discussed under

(1) The anatomical viewpoint
(2) Radiographic technique
(3) Deformities due to developmental irregularities
(4) Spondylolisthesis
(5) Deformities due to injury, and
(6) Deformities due to pathological changes in the bones and joints.

The subject is presented in a very elaborate and complete manner and is well illustrated. The monograph shows a tremendous amount of work done by the author. The bibliography alone occupies seven pages. The reviewer can do no better than give the writer's own conclusions:

"1. That developmental irregularities of the lumbosacral region of the spine may be present without giving rise to symptoms. The type and relative frequency —twenty-six and four-tenths per cent. of the series examined—of these must be appreciated in interpreting radiographs of this region, and a careful investi-

gation into all possible causes of the symptoms of which the patient complains should be made before attributing the symptoms to such an irregularity.

2. That the most frequent deformity associated with a developmental irregularity is the scoliosis due to asymmetrical sacralization of the fifth lumbar transverse process.
3. That the deformities due to developmental irregularities which alter the alignment of the vertebrae tend to become more pronounced with age.
4. That the characteristic indication of spondylolisthesis on an anteroposterior radiograph is the continuity of the outline of the transverse processes and the anterior border of the body of the fifth lumbar vertebra. The absence of this in the radiographs of some of the published cases suggests an error in diagnosis.
5. That spondylolisthesis is a relatively rare deformity.
6. That the prominent 'knuckle' deformity when present is often due to the projection of the fifth lumbar spine and not the upper border of the sacrum.
7. That a study of the specimens and radiographs of cases of spondylolisthesis negatives the suggested possibility of manipulative reduction of the displacement.
8. That spondylolisthesis occurs in children of both sexes, sometimes without symptoms, and that if due to trauma, the injury must have been in early life.
9. That severe trauma to the lumbosacral region in the adult can occur without producing spondylolisthesis.
10. That the consolidation which follows the treatment of tuberculous caries of the lumbosacral region of the spine obliterates the lumbosacral angle and reduces the possibility of spondylolisthesis.
11. That radiographs may not show any evidence of injury to the lumbosacral region until organization and calcification of the damaged structures have taken place, after which the radiographs taken at intervals show an increase in the deformity.
12. That symptoms and deformity following injury to the lumbosacral region in which osteo-arthritic changes have occurred may be more pronounced than would be expected from the degree of trauma.
13. That carcinoma and Paget's disease of the lumbosacral spine produce definite changes in the bone which can be recognized on a radiograph before any clinical deformity is apparent, and that the pain associated with these conditions may be referred by the patient to a recent injury."

DIAPHYSIAL ACLASIS (Multiple Exostosis) IN INDIANS. Lieut. Col. H. Stott and Raghunandan Lall. *British J. Surg.*, XVI, No. 64, 633, Apr. 1929.

Seven cases of this condition are described, four of them in one family. The disease is due to growth disorders in the cartilage, more particularly to the defect in the process of modelling new-formed bone into the preexisting shafts of the long bones. In the one family, cases have appeared in three generations and in the present generation two brothers and two sisters are affected.

CONGENITAL DISLOCATION OF THE HIP. H. A. T. Fairbank. *British Med. J.*, I, 459, Mar. 9, 1929.

The Lady Jones lecture of the University of Liverpool was delivered by Mr. Fairbank on the above subject. Mr. Fairbank discussed congenital dislocation of the hip in detail, commencing with the anatomical basis for the deformity. In his opinion, the primary anatomical fault is deficient growth of the upper acetabular margin, and to this all other changes are secondary. He described in detail the anatomical condition found in the deformity and the disturbance of muscle function which necessarily arises from the disturbed anatomical relationships. He regards the pain and increasing disability in adolescence or adult life as due chiefly to muscle strain, and to a lesser degree to arthritis. The ideal treatment, in his opinion, consists of closed reduction by manipulation at the age of one and one-half to two years. With increasing age reduction by

manipulation becomes increasingly difficult, so that after the age of nine for unilateral and of six for bilateral cases, he feels it inadvisable to attempt manipulative reduction. Open operation he thinks is seldom needed.—*R. I. Harris, M.B., Toronto, Ont.*

TREATMENT OF COLLES'S FRACTURE. A. S. B. Bankart. *British Med. J.*, I, 523, Mar. 16, 1929.

Bankart's paper is concerned chiefly with the treatment of Colles's fracture. After emphasizing the well known fact that the deformity associated with this fracture is threefold,—namely, displacement of the lower fragment upwards and backwards, radial abduction, and rotation about the transverse axis,—he makes the statement that Colles's fracture is produced by great force,—that is, the whole weight of the body falling upon the fixed wrist—and that *it requires great force to reduce it.* The reduction of a Colles's fracture is a matter of sheer force. There is no trickery about it whatever. He advocates reduction of the deformity over a wedge under deep anaesthesia, and rightly emphasizes the importance of perfect reduction.—*R. I. Harris, M.B., Toronto, Ont.*

MINOR ORTHOPAEDICS OF THE FEET IN GENERAL PRACTICE. John Fraser. *British Med. J.*, I, 524, Mar. 16, 1929.

The British Medical Association lecture delivered by John Fraser on the above subject covers in an interesting manner a number of the common but troublesome foot conditions. Included in the disabilities discussed are: ingrowing toe nail, hammer-toe, hallux valgus, hallux rigidus, march fracture, dancing fracture, Köhler's disease of the tarsal scaphoid, accessory tarsal bones, calcaneal spurs, apophysitis of the os calcis, and calcaneal bursitis. While Mr. Fraser has made no attempt to present any new or original ideas upon these subjects, the gathering together of such conditions into one lecture, and the entertaining manner in which he has presented them, make this a very valuable contribution to minor orthopaedic surgery.—*R. I. Harris, M.B., Toronto, Ont.*

ÜBER SPÄTSCHÄDIGUNGEN DES RUCKENMARKS (Kompressionsmyelitis) BEI SCHWEREN SKOLIOSEN (Late Damages of the Medulla in Severe Scoliosis). W. Jaroschy. *Bruns' Beitr. z. klin. Chir.*, CXLII, 597, 1928.

Compression of the medulla may be seen not only in congenital but also in rachitic scoliosis. The symptoms are generally seen during the time of the most rapid growth,—*i.e.*, in the fifteenth to nineteenth years. The seat of the compression is usually the most narrow place of the spinal canal at the height of the fourth dorsal vertebra. The myelography shows a total stop (in one case a temporary stop) above the summit of the main curve. In contrast to tubercular spondylitis, radical symptoms are generally lacking. The clinical picture of the paralysis is at once that of a cross-section paralysis, whereas in cases of tumor the symptoms are at first generally on one side only. The function of bladder and rectum are usually not affected. The anatomic lesion consists probably of a swelling of the medulla due to the congestion of blood and lymph. Conservative treatment is justified, but if relief is not obtained within a short time, laminectomy should be done. The laminae should be excised at the concave side. The dura should not be sewed, unless it is possible without tension.—*C. H. Bucholz, M.D., Halle, Germany.*

TREATMENT OF INJURIES OF THE HAND. Sterling Bunnell. *California and West. Med.*, XXX, 1, Jan. 1929.

In extensive injuries of the hand, any exposed joints should have a careful debridement and should be covered with tissue. This will give a better chance than drainage for obtaining a good functional joint. Nerves should not be sutured completely,—only brought in apposition with one suture. Secondary suture gives better results.

Tendons should be sutured completely at the primary debridement, while the tendon sheath is still present and before muscle contraction has separated the torn ends of the tendon. Such repair requires exact technique and scrupulous asepsis. If too much time is taken, too much trauma done to the tendon in suturing it, or too much suture material used, the result may be infection, sloughing, and a final condition worse than

the original lesion. If silk is used, suppuration may last for months until the silk has all been extruded. Chromic gut is better. Tendon suture should never be done as a primary operation after twenty-four hours have elapsed, because the great multiplication of germs by that time renders infection inescapable. After suture of flexor tendons, the wrist should be splinted in flexion for about a month.

Fractured phalanges and metacarpals may require continuous extension by means of adhesive on the finger with counterextension secured by a curved wire projecting beyond the fingers from a plaster cast on the arm. If the other fingers are held in the same position as the injured one, the tendons will not pull the fracture fragments out of position.

Carpal bones usually unite, except the scaphoid. This should be immobilized from fingers to forearm with thumb in strong abduction. Three months should be allowed for union in the bone.

After amputation of fingers, painful neuromata are common. These may be avoided by cutting the nerves very short and injecting with alcohol. Tendons should be left free from the stump, because if attached there may be interference with the action of the common muscle to other fingers. If the distal end of a metacarpal and its finger must be removed, the entire metacarpal should be taken out to insure a better shape to the hand.

Infections in the pulp of a finger tip should have free incision in U-shape, opening up a flap like the mouth of an alligator, with care not to open the tendon sheath. Lymphangitis, characterized by red streaks up the forearm, should be incised only at the point of original infection. Hot fomentations and rest usually suffice. Tendon sheath infections usually cause flexion of the finger. Incision should be lateral and, to avoid cutting the "pulleys" in the phalanges, should be opposite the joints. Thenar space infection should be opened at the flexor crease. Pus from a palmar infection may burrow under the wrist ligaments and collect in the quadrilateral space of the forearm, a space lying between the profundis tendon in front and the interosseous ligament behind and capable of holding eight ounces. This space should be opened by lateral incisions an inch above the wrist and anterior to the bones.

Drains should not be left in a hand more than two days. Hot compresses should be used, but not kept up too long because of over-stimulation of granulations and formation of adhesions.—*William Arthur Clark, M.D., Pasadena, Calif.*

MILZVERFLÜTTERUNG BEI GELENKTUBERCULOSE (Spleen Diet for Tuberculous Joints). O. Fliegel. *Deutsche med. Wchnschr.*, LIV, 2053, 1928.

As a working hypothesis, Fliegel considers the spleen to have important rôles in the struggle against infectious disease, in metabolic processes, and in bone regeneration. He cites Schroeder's experiment, showing a strong development of connective tissue about tuberculous areas after administration of spleen. A deficiency of spleen leads to disturbances of ossification processes.

The author observed during a period of ten months, twenty cases, on fifteen of which reliable judgment may be passed. He chose bad cases of suppurating tuberculous joints, suffering for months and years and unrelieved by the usual immobilization and heliotherapy. Five to ten decagrams of calf spleen, fried in fat, in soup, or minced, were given daily. Large quantities may lead to anaemia. In a few days to months a fall in temperature, a decrease in discharge, a healing and cleaning of the ulcer, an improvement in the general condition, and increase in appetite and in weight were noticed. Of the fifteen cases, two only must be considered to have had no improvement.

In the fight against toxins and disease causes, the disturbed tissue function must not be overlooked.—*Samuel L. Robbins, M.D., Cleveland, Ohio.*

VERSUCHE ÜBER FETTEINSCHWEMMUNG IN DAS BLUT BEI KNOCHENBRÜCHEN (Experiments of the Invasion of Fat into the Blood in Fractures). K. Flick and E. Traum. *Deutsche Ztschr. f. Chir.*, CCVII, 16, 1928.

At the Surgical Clinic of Heidelberg, Flick and Traum have made experiments on

animals in order to study the invasion of fat into the blood circulation after fractures. They noticed that the level of fat in the blood shows a marked increase within the first ten minutes after the injury, both in the artery and vein. During the further course the level of the vein increases still more, and becomes much superior to that of the artery. Intravenous injection of *Pituglandol* produces a marked decrease of the level of the fat within the blood.—*C. H. Bucholz, M.D., Halle, Germany.*

Über die Osteoplastische Freilegung des Fussgelenks (An Osteoplastic Approach to the Ankle Joint). Fritz König. *Deutsche Ztschr. f. Chir.*, CCXV, 196, 1929.

The rationale of the osteoplastic approach to the ankle is similar to that of the elbow, knee, and hip. By the removal of a part of the adjacent bone with its tautly attached muscles and ligaments, an extensive inspection of the joint is possible and the harm to the neighboring structures is obviated.

A curved incision starts just posterior to the internal malleolus, passes upwards about two or three fingerbreadths, crosses the tibia, and passes downward and forward, medial to the extensor tendons. With a wide chisel the internal malleolus with a substantial portion of the shaft is cut away in the sagittal plane. The malleolus with the attached ligaments is dissected downwards, exposing the ankle, subastragaloid, and Chopart's joints. In closing, the exact reposition of the bone surfaces is made with a nail or screw.

The author has used this approach successfully for arthrodeses of the ankle and for fracture-dislocations of the astragalus.—*Samuel L. Robbins, M.D., Cleveland, Ohio.*

Lorenz's Bifurcation. J. Hass. *Ergebn. d. Chir. u. Orthop.*, XXI, 457, 1928.

Hass gives an extensive report of Lorenz's bifurcation method which he thinks is entirely different and much superior to the methods of v. Baeyer and Kirmisson. The bifurcation is a reposition of an artificially made head into the acetabulum. The head is made by an osteotomy of the femur which runs obliquely from the posterior portion up to the anterior. The anterior point of the distal fragment is placed into the acetabulum. The height of the point of the osteotomy corresponds to the height of the acetabulum. A shortening of the leg is generally not noticeable, because the abduction of the leg and the resulting lowering of the pelvis compensates the length; in some cases even a lengthening of the leg was noted. After the operation, the leg is fixed by plaster-of-Paris in moderate abduction, mild extension, and slight inward rotation. By placing the patient on a sand pillow, the operation may be done on both sides at the same time.

The bifurcation is indicated in old cases of dislocation of the hip which have been irreducible, or in similar conditions,—such as pseudarthrosis of the hip, coxa vara luxans, severe arthritis deformans, tuberculous hip disease with severe displacement. In such cases the distal fragment of the femur should not be placed in the acetabulum, but just beneath the head against the lower border of the acetabulum. The results have been very good in fifty per cent., moderately favorable in thirty per cent. The poor results in the remaining twenty per cent. were due to technical errors—such as too marked abduction and too early weight-bearing.—*C. H. Bucholz, Halle, Germany.*

Muscle Transplantation in Paralysis of the Deltoid. G. Riedel. *Ergebn. d. Chir. u. Orthop.*, XXI, 489, 1928.

Riedel (Assistant of the Surgical Orthopaedic Clinic in Frankfurt) discusses the treatment of paralysis of the deltoid. He does not sanction arthrodesis because of the marked disadvantages,—such as elevation and wing-like deformity of the scapula, and secondary scoliosis. He prefers the transplantation of muscular tissue. For the anterior part of the deltoid the pectoral muscle is chosen, for the medial part the trapezius, and for the posterior part the teres major. He has done the operation in four cases with very good results. Disadvantages,—such as lack of power in the transplanted muscles or marked limitation of motion—he has not yet observed. The transplantation of the trapezius and the pectoral muscles is a so called pedunculated one, while the teres

major is cut on both ends but remains in connection with its vessels and nerves,—*i.e.*, a total transplantation.—*C. H. Bucholz, M.D., Halle, Germany.*

A Treatment of Fractures of the Hip. George A. Hendon. *Internat. J. Med. and Surg.*, XLII, No. 2, 66, Feb. 1929.

In this article, which was read before the Southern Surgical Association at Augusta, Georgia, in December 1927, the author reports a series of cases wherein he used a key for fractures of the hip.

The operation on the hip consists of exposing the trochanter or injured limb and with a Hudson or Murphy brace and bit bores through the cortex only, inserting a beef bone key three or four inches in length and three-eighths of an inch in diameter, driving it straight through the cancellous tissue of the neck into the head of the femur. The operator closes the wound with silk worm gut or silver wire, using no catgut at all, carrying the sutures to the bone, thus closing the tissues *en masse*. Hendon states that he has never found it necessary to ligate the vessels. The sutures are placed at sufficient depth and proximity to insure closure of all deep spaces and perfect control of hemorrhage.

The patient is then placed in bed with sand bags along the outer aspect of the leg to resist muscle pull and external rotation and eversion of the foot. The patient can be moved about in bed without fear of refracture because a three-eighths-inch pin is stronger than the neck of the bone in old people, according to the author.

The patient can be allowed out of bed as soon as the wound in the soft tissue has healed.

The author states that he has found the use of the key to be both practical and preferable in all fractures of the long bones that confine patients to the bed, and in all cases of non-union and vicious union, not excepting compound and complicated fractures. The only fracture so far found to contraindicate their use is the pathologic fracture.

The keys can be obtained in any size, either square or round. The author prefers square keys with round holes. The author concludes, stating beyond any doubt that these keys do not act as foreign bodies or become sequestra even in the presence of suppuration.—*H. Earle Conwell, M.D., Fairfield, Ala.*

Acute Osteomyelitis. Dean Lewis. *J. Am. Med. Assn.*, XCII, 783, Mar. 9, 1929.

The infection, in most cases staphylococcus, is hemotogenous and is influenced in localization by trauma and the arrangement of blood vessels in the metaphasis. It is important to recognize the manner in which the infection spreads, whether from the focus to the medullary canal, then out through the haversian canals to the periosteum; or directly from the focus through metaphyseal tissue to the periosteum with stripping, then backward to the marrow, as shown by Starr. The author has observed a marrow infection without periosteal stripping, and has seen the latter without appreciable involvement of the marrow.

Early operation of a conservative nature should be done, and if an abscess is found outside or under the periosteum it should be drained and not opened through the cortex. If infection is not found beneath the cortex, the marrow cavity should be exposed. Removal of a sequestrum should be delayed until it has fully separated. Early recognition of the disease and immediate drainage of the focus will lessen the extent of bone destruction and the serious sequellae so frequently following.

The report is based on a study of 229 cases.—*W. B. Carrell, M.D., Dallas, Tex.*

Chronic Ulcer of the Leg: Report of 300 cases treated with a modification of the original Unna's paste bandage. Joseph W. Sooy. *J. Am. Med. Assn.*, XCII, 1157, Apr. 6, 1929.

Eighty-five per cent. of the cases show satisfactory healing with the application used with the same technique as advised by Unna.

Advantages for the preparation are that it is more porous, flexible, and antiseptic.

Formula for modified Unna's paste:

Glycerine	1900 gm.—1425 cc.
Gelatin	625 gm.
Water	1900 cc.
Zinc oxide	250 gm.
Phenol	1.50% of total volume

4675 gm.—10 lbs. (Sufficient for seven dressings.)

While warm, a coat of the paste is applied, from toes to knee with a brush. A simple spiral bandage is applied over the paste and the process repeated until there are three layers of bandage and four coats of paste.

The patient may continue activity. Dressings should be changed as often as indicated by soiling from drainage. The paste bandage may be left in place from three to twelve weeks.—*W. B. Carrell, M.D., Dallas, Tex.*

AIR INSUFFLATION IN TREATMENT OF ACUTE GONOCOCCAL SYNOVITIS OF KNEE JOINT. Wm. B. Porter and J. E. Rucker. *J. Am. Med. Assn.*, XCII, 1513, May 11, 1929.

Five cases are reported with proven Neisserian infections, of serofibrinous or purulent type, in which immediate and lasting improvement was obtained and rapid cure in an average of twenty-three days.

The technique described is essentially distention of the joint with air, controlled by the sphygmomanometer to twenty-five millimeters of mercury pressure. Not more than three injections were required in any case.

In no case was there a remaining painful knee or partial ankylosis.—*W. B. Carrell, M.D., Dallas, Tex.*

FASCIAL TRANSPLANTS IN THE TREATMENT OF CERTAIN DISLOCATIONS. Alexius McGlannon. *J. Am. Med. Assn.*, XCII, 1584, May 11, 1929.

The acromioclavicular and the inferior radio-ulnar joints depend upon ligaments for security, and when these are torn, repair is frequently incomplete with resulting disability in the joint. Two cases of acromioclavicular dislocations which involved laceration only of the ligaments at this joint are reported. In each case a strip of fascia lata was passed through a drill hole in each bone and securely fastened. Results were good. This procedure would not be adequate were the conoid and trapezoid ligaments torn. Fascia lata was also used, successfully, in a case of posterior radio-ulnar dislocation.—*W. B. Carrell, M.D., Dallas, Tex.*

RELATION OF STREPTOCOCCI TO THE SPINAL FLUID IN EXPERIMENTAL POLIOMYELITIS. P. K. Olitsky, C. P. Rhodes, and P. H. Long. *J. Am. Med. Assn.*, XCII, 1725, May 25, 1929.

Working with the same yeast medium used by Rosenow, and with other media, the authors were not able to grow a streptococcus from the spinal fluid of active monkeys which differed in any way from a streptococcus obtained from the brain of normal monkeys and from the laboratory air.

Working with the Rosenow spinal fluid strain, the same effect was produced on rabbits,—namely, a streptococcus septicaemia—as was obtained when streptococci from laboratory air were used. The Rosenow strain produced the same effect when injected into the brain of an immune monkey as it did on a stock monkey.

In twenty-four examinations of stained film preparations of centrifugalized spinal fluid from nineteen monkeys showing characteristic experimental poliomyelitis, streptococci were not found. The streptococci obtained by Rosenow from the spinal fluid of a patient is essentially the same as the streptococci isolated from the brain of a normal monkey and from the laboratory air.

The authors do not find evidence to support the view that the spinal fluid is a medium for the virus in poliomyelitis and their negative results are in support of the view that

the streptococcus is not identical with the filterable virus of this disease.—*W. B. Carrell, M.D., Dallas, Tex.*

LOOSE BODY UNDER THE EXTERNAL SEMILUNAR CARTILAGE OF THE KNEE. Emil S. Geist. *J. Am. Med. Assn.*, XCII, 1751, May 25, 1929.

Two cases are reported with a loose body in the lateral portion of the knee joint with active clinical manifestations and positive roentgenographic findings. In each case the joint was explored and the body was found completely hidden underneath the external cartilage.

The external semilunar cartilage has sufficient width and adequate space between it and the tibia to conceal a small flat object the size of a penny or button.—*W. B. Carrell, M.D., Dallas, Tex.*

PROPER SHOEING OF THE CHILD. John D. Adams. *J. Am. Med. Assn.*, XCII, 1753, May 25, 1929.

"Shoes are made to sell and not to wear." "The public wants what it wants and not what it needs."

The baby's foot has few bones, a heavy pad of fat, and needs room for development during the early years. A correct shoe for the infant should be soft sole and upper, without any conformation to the foot. Between two and five the child needs a little more protection. The seven-point shoe should have breadth of toe, adequate length (one-half inch longer than a full impression of the weight-bearing foot), depth and fulness of the toe, close-fitting well shaped heel, depth on the dorsum at the vamp from the ankle to the metatarsophalangeal joints, broad flexible sole with a straight outside line, and height of the heel varying with the patient's age. Starting with the paper bag shoe, up to three and one-half years the heel and sole should be the same. Three and one-half to five years, the heel should be twice the thickness of the sole.—*W. B. Carrell, M.D., Dallas, Tex.*

THE TREATMENT OF PARALYSIS IN TUBERCULOUS SPONDYLITIS. S. Lurie. *J. sovremennoi Chir.*, IV, No. 19, 163, Jan. 1929.

Two cases are reported which have responded with complete restoration of function after puncture and evacuation of the paravertebral abscesses. In both instances the abscess seems to have compressed the respective area in the spinal cord and has produced a secondary paralysis of the lower extremities. This form of conservative procedure is indicated when it is assumed that the abscess is not joined with the structures of the spinal cord.—*A. Gottlieb, M.D., Los Angeles, Calif.*

THE VALUE OF SEDIMENTATION REACTION IN BONE TUBERCULOSIS IN CHILDHOOD. S. Rollje. *J. sovremennoi Chir.*, IV, No. 19, 173, Jan. 1929.

The author has investigated the value of this reaction to confirm the diagnosis of tuberculous bone involvement, and arrives at the conclusion that in only thirty per cent. of a large number of cases has this reaction substantiated the clinical and roentgenological findings. In the majority of cases—seventy per cent.—the red-blood-cell-sedimentation test does not serve as a criterion, because the readings obtained are subject to so many and various influences which have no relation to the existing disease process. His conclusions are that the clinical and x-ray findings are, as before, the evidences for tuberculous bone affections.—*A. Gottlieb, M.D., Los Angeles, Calif.*

FRACTURES IN CHILDHOOD. L. Alexandrov. *J. sovremennoi Chir.*, IV, No. 19, Jan. 1929.

Fractures in children deserve special consideration, because their mode of production as well as therapeutic procedures differ somewhat from fractures in adult life. The author bases his statistical data on a large number of ambulatory cases as well as those treated in hospitals. The number of the first was 1749; the second group consisted of 202 clinical cases. Of the ambulatory patients, forty-two per cent. were clavicle fractures; of the hospitalized patients, sixty-six per cent. were fractures of the femur. A rise of temperature was noticed in 170 cases, and in sixty-two instances the tempera-

ture lasted several days,—as long as twelve days. A review of the material shows that 220 patients fell from high levels; one case of death occurred and forty-three concussions of the brain, while the others offered no symptoms of any consequence. In the chapter on skull fractures a few instances are quoted in which the patients presented the syndrome of hydrocele cranii traumatici.—*A. Gottlieb, M.D., Los Angeles, Calif.*

EPIPHYSEAL OSTEOMYELITIS OF THE LONG BONES AND ITS TREATMENT. A Rjabinkin. *J. sovremennoi Chir.*, IV., No. 19, 27, Jan. 1929.

This affection is an independent nosological manifestation. It is accompanied, as a rule, by involvement of the proximal joint. Unanimous involvement of the epiphysis and diaphysis is a very rare occurrence. The most frequent age of affection is under two years, occurring more often in boys than in girls. The severity of the disease depends upon the location and the extension of the process into the surrounding soft tissues.

The treatment should be most conservative,—aspiration of the joint empyema; in more extensive involvement, incision of the joint and drainage through small openings. If the soft tissues about the joint are involved, an arthrotomy is indicated. The bone itself should be left untouched. Resections are indicated only in hip joints, in sequestration of the entire epiphysis, and in cases of separation of the diaphysis.—*A. Gottlieb, M.D., Los Angeles, Calif.*

THROMBO-ANGIITIS OBLITERANS (Beurger's Disease). A. M. Rechtman. *Med. J. and Rec.*, CXXIX, 367, Apr. 3, 1929.

This is a very comprehensive review and correlation of this subject. It is based on a series of cases seen in the writer's office and hospital practice. All of the patients had symptoms for several years. He reviews the etiology, pathology, findings, differential diagnosis, and treatment. Under the last he lays stress on the importance of prophylactic treatment and active treatment to increase the collateral circulation in an attempt to avoid the so often inevitable amputation.—*Richmond Stephens, M.D., New York, N. Y.*

CORRECTIVE APPARATUS FOR LATERAL CURVATURE OF THE SPINE. Carl R. Keppler. *Med. J. and Rec.*, CXXIX, 404, Apr. 3, 1929.

The writer describes an apparatus which he uses in connection with gymnastic work for cases of scoliosis. The fundamental principle is that of weight and lever and pressure-pad corrective force.

He uses it as:—

1. A passively corrective apparatus in total lateral curvature.
2. A passively corrective apparatus in double dorsolumbar curvature.
3. An active resistant apparatus in total or lumbar curvature.
4. An active resistant apparatus in lumbar anterior curvature,—*i.e.*, hollow back.—*Richmond Stephens, M.D., New York, N. Y.*

ACUTE OSTEOMYELITIS IN CHILDREN. R. B. Wade. *Med. J. Australia*, XVI, 264, Mar. 2, 1929.

"Acute hematogenous osteomyelitis is an infection of the blood stream, of which the inflammation in the bone is the local manifestation."

The initial focus is always in the juxta-epiphyseal region. The tissue involved is the bone marrow,—both the yellow marrow of the medullary cavity and the red marrow of the cancellated bone. The deep layer of the periosteum is continuous with the marrow through the canals of the haversian system.

The arrangement of the capillaries in the metaphysis slows the blood current and favors the deposition of emboli. The causative organisms in order of frequency are: staphylococcus aureus, pneumococcus, streptococcus, and staphylococcus albus. The staphylococcus aureus is far the most virulent. In a series of one hundred cases the disease was more frequent among boys, from ten to fifteen years, and among the poorer classes. The bones involved in order of frequency were: tibia, femur, fibula, humerus,

ulna, os calcis, mandible, clavicle, ilium, radius, metatarsal bones, phalanx, astragalus, and scaphoid. The only other parts infected, in this series, were endocardium, pericardium, and joints. The case mortality was fifteen per cent., caused by septicaemia, pyaemia, endocarditis, pericarditis, nephritis, and pneumonia. The causative organism undoubtedly has a specific selective action.

Pus may travel under the periosteum, perforate it, and come to the surface (mild cases); or may involve red marrow and medullary canal (severe cases). It may extend into the joint. Sequestra are usually of dense cortical bone which necroses because of stripping of the periosteum. In infants under three months of age the source of infection is usually the umbilicus, and the causative organisms, the streptococcus or pneumococcus. Commonly there is a septic arthritis. The outlook is usually good, although with hip joint involvement there often follows an ankylosis.

X-ray is of no value in diagnosis until about the fourteenth day. Infection of the neck of the femur is always associated with arthritis of the hip and ultimate ankylosis. When the lower metaphysis is attacked the knee joint is often involved; as is the ankle joint in infection of the lower tibial metaphysis, and the elbow joint in the lower humeral; but upper tibial involvements seldom invade the knee. In the ilium the subperiosteal effusion is usually on the inner surface of the bone and the mortality rate is high. Tarsal osteomyelitis usually involves the neighboring joints.

The prognosis depends upon the relationship between virulence of infection and individual resistance. A favorable issue can be expected only if pus is produced. Many of the secondary bone infections are of such lessened virulence as to be recovered from without operation. Septicaemic and severely toxic attacks are grave; otherwise the outlook is good, fatality seldom occurring from prolonged suppuration and absorption.

No treatment of the blood stream infection seems of value. The author hopes that the day of "guttering" the whole length of the spongy bone is gone. He feels that a small opening through the cortex at the region of the metaphysis is enough, together with free incision of the periosteum and the removal of that shell of white avascular cortex from which the periosteum has been stripped off by pus, and with removal of sequestra later as needed.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Acute Osteomyelitis. W. Vickers and M. B. Sydney. *Med. J. Australia*, XVI, 268, Mar. 2, 1929.

With the finding of a definite spot of tenderness at the end of a long bone and a temperature otherwise unexplained, an incision down to the bone should be made at once; and on failure to find pus, a dissector should be passed around the bone under the periosteum. Still failing to find pus, the cancellous bone should be drilled, and if pus is located the cortex should be removed with a gouge until the limit of the suppuration is reached. This will tend to limit necrosis. The compact bone should be removed for one-third of the circumference and in length as far as pus is found in the medulla. Wider resection is unnecessary. A deep and narrow cavity or a series of drill holes cannot fill up and heal, for mechanical reasons.

The joints above and below must be protected by splinting, bracing, or extension against fixation in malposition resulting from contractures of soft tissues involved in the lesion.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Arthritis. John T. O'Ferrall. *New Orleans Med. and Surg. J.*, LXXXI, No. 11, 809, May 1929.

In this paper the author has given a very good description of the classification of the various types of arthritis, and interpretation of the symptoms found. He stresses the importance of making a careful investigation as to the causes of joint inflammation and speaks of the acute type such as gonorrheal arthritis; then refers to the so called metabolic arthritis, the osteo-arthritis or hypertrophic arthritis being an example, and then to the atrophic or nutritional type of arthritis.

After speaking of the usual cases and treatment of this latter type, the intestinal tract is spoken of as a cause of infection and free purgation and colonic flushes are advised when this cause is found to be active.—*Edward S. Hatch, M.D., New Orleans, La.*

AMOUNT OF DESTRUCTIVE CHANGES FOUND IN THE BODY OF THE VERTEBRAE BY ROENTGENOGRAPHY. A. Chasin. *Orthopedia i Travmatologia*, III, 22, 1928.

The author has attempted to find how much a definite artificially produced destruction of vertebrae in cadavera would show on x-ray examination. He comes to the following conclusions:

Small defects of the vertebrae do not show when examined in the anteroposterior plane. The absence of the greater part of the body, with conservation of the epiphysis and the posterior part of the body only, is not indicated by any changes in density on anteroposterior view, unless a gibbus is present or the axis of the defect coincides with the central beam of the tube. In cases where the cortex of the body is intact, defects of the central part equal to a quarter of its size are not revealed by lateral view. Destructions involving the spongy tissue of the sacral vertebrae, when the cortical covering is preserved, do not show an equivalent in the roentgenograms on x-ray analysis.

It appears that not all the constituents of the vertebrae have an equivalent importance in the production of the x-ray picture. The cortex is the most important.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

FRACTURES OF THE NECK OF THE FEMUR IN CHILDREN. A. Demidow. *Orthopedia i Travmatologia*, IV-V, 57, 1928.

This was considered a rare occurrence before the advent of the x-ray diagnosis and there is still a question whether epiphyseolysis is not a more frequent affliction. The fracture of the neck in children has a special significance, as very often the diagnosis is not made early and a coxa vara (traumatic) deformity develops.

Among the etiological factors trauma is important, though sometimes overlooked. Rickets, hypoplastic bone atrophy, osteogenesis imperfecta, endocrine changes, and undiscovered foci of osteomyelitis may all be responsible for the fracture. Clinically, certain peculiarities are met with. Often the little patient does not remember the injury, the pain does not last long, and he continues to use his limb. Sometimes there are typical symptoms of fracture with adduction, extension, external rotation, and shortening. Fractures do not often occur before the ossification of the neck is complete. Up to four years of age they are seldom observed. The periosteum suffers little during the injury and supports the nutrition of the fragments as long as the patient does not use his extremity; but as soon as the pain has disappeared and the leg is used again, the periosteum stretches and tears, the circulation is disturbed, and consequently the formation of a normal callus becomes impossible.

The diagnosis of this type of fracture is often difficult; the possibility of a congenital dislocation of the hip, different types of infection, coxa vara congenita, and other affections must be kept in mind. The author strongly advises prolonged periodical observation of children with injury to the hip. The treatment in early cases consists of reduction and application of plaster spica for a varying period of time. When non-union is present the usual operative methods are indicated. In untreated cases the author advises the conservative procedures of Prof. Turner, application of a Thomas splint, Lorenz's bloodless reduction, or the usual surgical procedures.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

THE USE OF A HERNIAL SAC FOR ARTHROPLASTY. A. Bondartshuk. *Orthopedia i Travmatologia*, IV-V, 95, 1928.

A case is reported of a patient suffering simultaneously with an anterior dislocation of the right shoulder and an inguinal hernia. The patient could not use the arm; adduction and elevation were impossible.

The joint was opened through the deltoid. The head of the humerus was densely adherent to the capsule; the glenoid cavity covered with dense scar tissue. The her-

niotomy was then performed and the hernial sac was used to cover the head of the humerus. Five months after the operation the patient had a normal range of motion in the shoulder.

The author believes that the success is due to the use of the sac and recommends the use of it in suitable cases. He also believes that in biologically related cases homotransplantation could be attempted.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

La Pulverisation des Extrémités Articulaires (The Pulverization of the Articular Extremities: The Pathogenic Mechanism of the Deforming Arthritis). P. Moulonguet. *Presse méd.*, XXX, 482, 1929.

The extraordinary uniformity of the arthritides, whether they be tuberculous, rheumatic, syphilitic, traumatic, or static, has led the author to believe there is a common mechanical origin. All arthritic joints are more or less characterized by the simultaneous existence of an atrophic process leading to destruction and the hypertrophic which produces the periarticular constructions. He has found included in the synovia small bits of dead bone, detached from the articular extremities and taken up by the membrane after projection into the joint. These small sequestra assist in the formation of osteocartilaginous tissues producing the typical lesions of ecchondrosis, osteophytes, and free bodies. In the early stages of the infectious arthritis the reddened, thickened synovia is an evidence of a vasomotor disequilibrium which is accompanied by an osteoporosis and a relaxation of the muscles, as suggested by Leriche and Albert.

Mild traumata can set the arthritis deformans in evolution. The vicious articulations of the congenitally deformed and of the rachitic are constantly submitted to microtraumata. Senile, endocrinal, or traumatic osteoporosis is frequently complicated by arthritis. It is the fragility of the bone, not the trauma or bad posture, which produces the wearing away. Also, the arthropathy of nervous origin is an arthritis of mechanical origin which develops in an anaesthetic articulation; the motor incoordination leads to numerous small and great traumata.

The prevention of mechanical disorders by apparatus and operation and the improvement of the quality of the bone are, then, the directing motives in the treatment.—*Samuel L. Robbins, M.D., Cleveland, Ohio.*

Fractures from an Operative Viewpoint. Melvin S. Henderson. *Radiology*, XII, 214, Mar. 1929.

The Committee on Treatment of Simple Fractures, of the British Medical Association, concluded, in 1912, that results of operative and non-operative treatment, in children, are practically the same. As the age of the patient advances, there is a progressive depreciation of the functional results from non-operative treatment.

At nearly all ages operative treatment produces a higher percentage of good results than non-operative. While there may be good functional result with poor anatomic result, the most certain way to obtain good function is to secure a good anatomic result, and a method which does not promise a good anatomic result should not be chosen.

Operative treatment should be instituted promptly after the accident, and not following the failure of non-operative measures. The mortality rate directly due to operative treatment of fractures is so low that it can not be used as an argument against operation. However, operative treatment by untrained or inexperienced men, or in ill equipped hospitals, is dangerous. Sir Robert Jones remarks that the surgeon having the least mechanical resources will operate most frequently.

The Committee of the American Surgical Association found that only fifty-seven per cent. of non-operated patients secure a good anatomic result and only sixty-five per cent. a good functional result. Good functional results are much more easily secured in children than in adults. Open operation gives anatomic reposition in seventy-five per cent.

Before the War there was probably too much operative treatment of fractures; since the War, the pendulum has swung to ultraconservatism. The present trend is toward

more frequent open reduction, because of the constant attention and supervision necessary in traction methods.

The advice to always try conservative treatment seems unsound to the author. It is difficult or impossible to lay down rules as to what fractures should be treated by open methods and what conservatively.

In the Mayo Clinic, the following fractures are treated by open operation:

(1) Fractures of the astragalus, if there is marked displacement.

(2) Pott's fracture, where the internal malleolus is broken off high and well into the articular surface of the tibia.

(3) Ankle fractures with the astragalus wedged between two fragments of the tibia, the foot being displaced posteriorly.

(4) Spiral fractures of the lower third of the tibia and fibula.

(5) Fractures of the patella.

(6) Most fractures of the shaft of the femur in adults, particularly those in the lower third, with posterior displacement of the lower fragment.

(7) Fracture-dislocations of the hip.

(8) Slipped epiphysis of the upper end of the femur in children.

(9) Overriding fractures of the metacarpals.

(10) Comminuted fractures of the scaphoid.

(11) Most fractures of shaft of both radius and ulna.

(12) Most fractures of the lower third of the radius, except the typical Colles'.

(13) Most fractures of the head of the radius.

(14) Fractures of the olecranon.

(15) Certain fractures or epiphyseal separations of lower end of humerus in children, particularly if the lower fragment is displaced anteriorly.

(16) Fractures of the surgical neck of the humerus that are overriding.

(17) Fracture-dislocation of the head of the humerus.

Delay in setting a fracture is responsible for faulty reductions more often than any other factor. The following open methods are used:

(1) As the method of choice in open reduction, the fracture site is opened, the fragments replaced in normal line without internal splintage but with maintenance of the position by external splinting.

(2) The ends of the bones are replaced and are sutured together by absorbable sutures or wire.

(3) Metal bands, as those of Parham or Putti, are useful in oblique or spiral fractures, but should be removed after union is secured.

(4) Metal plates, as those of Lane or Sherman, are probably the best internal fixation for fractures of the shafts of long bones. They are readily available and their application is quick and simple, this advantage offsetting the physiological desirability of the more difficult bone graft.

(5) Intermedullary beef-bone pegs are not in as much favor as formerly, and are merely foreign bodies to provide fixation.

(6) Beef-bone screws and plates are convenient and are usually entirely absorbed.

No matter what technique is used, adequate postoperative fixation must be provided. Old fractures demand open interference for (1) malunion or (2) non-union. Malunion demands osteotomy, often with internal fixation, for which the metal plate offers the best means.

Ununited fractures are divided into those with delayed union and those in a fixed state of non-union. Consolidation may be induced in delayed union by various means, but in non-union nothing but operation will succeed. The bone graft is the best means for awakening osteogenesis. In humerus, radius, ulna, and femur, the author has found the massive graft best. The inlay graft is excellent in certain situations. The massive graft is cut through the entire thickness of the bone, the medullary portion removed but the pieces saved, leaving a flattened bone plate to be applied to a corresponding

surface made flat on the cortex of the fragments, and held in place by beef-bone screws or by autogenous pegs.

The small pieces of bone removed are then wedged in and around the fracture line. The osteoperiosteal graft has been a disappointment. The graft itself must not be depended upon at any stage to bear any strain.

The use of the open method as a routine is not advocated. But too vigorous manipulation to secure reduction by closed method is harmful, and in such cases immediate operation is preferred. The experienced surgeon should be able to distinguish fractures which can be reduced conservatively from those that require open operation.—*Edward N. Reed, M.D., Santa Monica, Calif.*

THE NATURE OF ARTHRITIS, WITH CONSIDERATION OF THE RATIONALE UNDERLYING SOME FORMS OF PHYSIOTHERAPY USEFUL IN THIS DISEASE. Ralph Pemberton. *Radiology*, XII, 235, Mar. 1929.

Arthritis is the oldest known disease, and afflicted the dinosaurs long before the advent of man. Interest in it is being aroused by the realization that it constitutes one of the great scourges of society. Rapid progress in its treatment began with the recognition of focal infection as a cause. This, however, constitutes only a part of the problem.

Recent study has shown that a fifth of all cases show a decrease in basal metabolism. Metabolism of nitrogen, fats, calcium, phosphorous, and uric acid seems normal, but there is a delayed removal from the blood of ingested glucose, which closely parallels arthritis and focal infection. With removal of a causative focal infection and cure of the arthritis the delayed removal of sugar returns to normal. With the delayed removal of glucose, there is a delayed utilization of oxygen in the smaller vessels, apparently due to a change in circulation, a tendency toward vasoconstriction, with a relative anaemia, in some of the tissues. This can, to some extent, be counteracted by vasodilator drugs.

Study of the capillaries of the arthritic shows that these contain less blood than normal, and a more sluggish, interrupted stream. Hypertrophic arthritis has been produced experimentally by interference with circulation.

It is known that exercise, massage, and heat are among the most useful measures in treatment of arthritis. Their benefit probably depends upon their influence on circulation. Exercise has been shown to induce a systemic acidosis, while heat, systematically applied, leads to an alkalosis induced by the loss from the body of acid bodies, chiefly carbonic acid, from overventilation of the lungs. Massage, while partaking somewhat of the nature of exercise, cannot be shown to have any such influence on the acid-base equilibrium as either heat or exercise.

Both heat and exercise increase the circulation and cause a sharp rise in the oxygen percentage saturation of the peripheral blood, and an increase in the red-cell count. Massage also increases the red-cell count. Evidently the effect upon arthritis of exercise, heat, and massage is due to their influence on the peripheral circulation.—*Edward N. Reed, M.D., Santa Monica, Calif.*

FRACTURES OF THE FEMUR. W. L. Estes. *Radiology*, XII, 239, Mar. 1929.

This paper deals with simple fractures of the shaft of the femur. Over eighty per cent. are caused by indirect violence, and in most instances are accompanied by serious injury to soft structures.

No attempt should be made to "set" a fractured femur as a first aid measure, unless proper splintage is at hand. To immobilize in the position of distortion is indicated, unless a Thomas splint is at hand in which the limb can be straightened, immobilized, and transported. In the examination the fragments should be moved very little.

There are two general methods of treatment: (1) immediate reduction and fixation; (2) gradual reduction, by suspension traction methods.

Immediate reduction is accomplished by closed or open procedures. The splint or other fixation should be selected to fit the case, and not the fracture fitted to some certain splint. Displacement and distortion will depend upon the extent and severity of

the injury to the soft tissues. Some muscles may be put out of action and others thrown into spasm, so that distortion may be atypical. Each case must be treated according to its carefully determined individual requirements.

Most fractures of the femoral shaft are transverse or bluntly oblique. The fragments of such fractures, once placed end to end, need no further traction, but should be jammed together and adequately fixed, preferably in plaster-of-Paris, while the patient is still under anaesthesia, the cast being then suspended from overhead. The reduction is accomplished on a traction table. If the x-ray, after twenty-four hours, shows the fragments to have slipped by, the whole procedure should be repeated. After two unsuccessful attempts, some other method should be tried. The author then uses open operation, with fixation by metal plate. One-quarter end on, with proper alignment, will give satisfactory results, but the author believes that any overriding will be unsatisfactory. The suspension-traction method should be used for fractures of the upper third and for very oblique or spiral fractures lower down. This method requires constant and skilled adjustment, and is consequently irksome to the surgeon unless he has well trained assistants or attendants. However, this method has the following decided advantages: motion of the knee and ankle joints; and early massage. Skeletal traction avoids the prolonged pull on the structures of the knee joint.

Fractures with very considerable laceration of soft parts should be treated at once by operation. Open operation should not be delayed longer than ten days after the occurrence of the fracture. The author has used it in thirty-eight per cent. of his cases, and has had good results. Passive movements of knee and ankle and massage should be begun at not later than three weeks. Eight weeks is the average time required for fixation or persistent traction. A brace should then be used to carry the weight for another six or eight weeks.

Delayed union and non-union result usually from faulty reduction and immobilization, but may be caused by tight dressings or lack of passive movement and massage. It is not necessary to prevent all movement at the site of fracture. Interposition of fascia and muscle may also cause delayed union, or non-union. This may sometimes be overcome by rubbing or jamming the ends together. Systemic disease may cause non-union and should always be carefully considered.

The report of the Committee on Fractures of the American Surgical Association, in 1921, states that of all of the fractures of the femur reported from the United States and Canada as treated by non-operative methods, eighty-seven per cent. made good functional recoveries; only forty-two per cent. had good anatomic results; forty-two per cent. moderate anatomic results; and fifteen per cent. bad anatomic results. It is evident that good function may occur with poor anatomic results, but good anatomic restitution entails a shorter period of disability.

As to results from operative treatment: The operated cases showed sixty-eight per cent. anatomic results, as against forty-two per cent. in non-operative cases; but non-operated cases rated eighty-seven per cent. in function, as against seventy-seven per cent. in operated cases. Moreover, the period of disability was about one month longer in the operated cases. The report of the Committee on Fractures of the American Surgical Association shows the period of disability in cases under fifteen years of age to be four or five months; and in all over fifteen years to be eight months. In operated cases the period averages nine months.

The period of disability is figured as the time from the injury until the patient is able to return to his former, or an equally active employment. Following this period there is usually a gradual improvement, so that it requires several years to reach a stationary condition in which there is no further improvement. The author thinks that in civil life the stationary period for fractured femora is reached in three years.

Passive movement and massage should be begun early, often by the end of the third week; diathermy was found very useful, especially in delayed union. Cases should be braced for at least one month after beginning weight-bearing.—*Edward N. Reed, M.D., Santa Monica, Calif.*

PATHOLOGICAL DISLOCATIONS OF THE HIP. A. Bruce Gill. *Southern Med. J.*, XXII, 207, Mar. 1929.

This paper is based upon forty-four patients operated upon. The pathological dislocation was caused by: tuberculosis (27 cases), acute pyogenic infections (10), infantile paralysis (5), encephalitis (2).

In the tuberculous patients surgery is indicated to secure: (1) stability of the hip, (2) freedom from pain, (3) correction of marked and disabling deformity, (4) motion.

The author prefers the reconstruction operation to either osteotomy or arthrodesis.

Results in cases due to tuberculosis: twenty-one, good (10 ankylosed, and 11 some motion); three, fair; three, poor. In none of the twenty-seven cases has there been any evidence of a rekindling of the tuberculous process after operation. Results in dislocations due to pyogenic infections—the reconstruction operation: of ten cases, seven were good, with motion; two have fair results; one died of acidosis two days after the operation.

Results in dislocations due to infantile paralysis: arthrodesis used in two cases, with satisfactory results; reconstruction operation used in three cases,—two cases greatly improved, one relapsed.

In two cases due to encephalitis, three joints had reconstruction operations with results in two cases good, in one a recurrence.

Conclusions: Pathological dislocation of the hip presents many of the same problems and difficulties as old unreduced congenital dislocations. The average good results obtained by operation justify surgical procedure. This statement holds true in tuberculosis of the hip as well as in other conditions of the hip. The surgeon may secure either an ankylosed hip in good position, or in favorable circumstances may secure enough motion to be valuable.—*F. G. Hodgson, M.D., Atlanta, Ga.*

LEG LENGTHENING. W. B. Carrell. *Southern Med. J.*, XXII, 216, Mar. 1929.

The author reports lengthening the tibia in twenty-one cases, and the femur in seven. The shortening in these cases was due to poliomyelitis, twenty-six cases; old tuberculous hip, one; and epiphyseal damage, one. The average increase in length obtained was one and three-quarters inches. The method of lengthening the tibia and the apparatus used is practically the same as that described by Dr. Leroy Abbott, except that a third pin is inserted to prevent the anterior bowing which tends to occur. In the twenty-one cases of the lengthening of the tibia, there were four complications due to faulty technique; of these, two were failures. There were no infections, no mortality. He concludes that leg lengthening, both in the tibia and in the femur, is a feasible surgical procedure. It is a major surgical procedure, requiring unusual surgical technique and most careful and detailed after-care.—*F. G. Hodgson, M.D., Atlanta, Ga.*

INFLUENCE OF PYOGENIC AND TUBERCULOUS INFECTIONS UPON EPIPHYSEAL ACTIVITY, AND GROWTH OF BONE. Albertus Cotton. *Southern Med. J.*, XXII, 303, Apr. 1929.

The author reports four cases of diffuse osteomyelitis of the long bones with actual lengthening of the bone; also two cases of tuberculosis of the knee with three-eighths inch lengthening of the legs. There is one case reported with one inch shortening due to osteomyelitis damaging the epiphysis. Illustrations and radiograms show the conditions. —*F. G. Hodgson, M.D., Atlanta, Ga.*

SPONDYLOLISTHESIS AND ITS SIGNIFICANCE FOR THE STATIC INSUFFICIENCY OF THE VERTEBRAL COLUMN. H. Turner. *Ztschr. f. orthop. Chir.*, LI, Heft. 1, 1929.

After a review of the literature, the author presents three of his cases selected from a considerable number. Judging from the skeletal changes, it would seem that the unsure fixation of the vertebral column upon the sacrum and the unfavorable position of the line of gravity make the equilibrium of the spine upon the pelvis and the support in the

hip joints a very labile and laborious one. He does not believe with Leri that the lumbarization of the first sacral contributes to the formation of spondylolisthesis. He maintains the classic spondylosis to be the etiologic factor in the production of spondylolisthesis. Failure of fusion of the constituent parts of the lamina of the fifth lumbar is no great rarity and it is not unlikely that various subjective pains and postural abnormalities are attributed to this cause.

Roentgenograms of the sacrolumbar region of aspirants for hard bodily labor, as suggested by O'Reilly, would not be amiss. The author is acquainted only with Albee's report of fusion results and is not convinced of the efficiency of present operative methods. He uses corsets with some relief in even severe cases.—*J. E. Milgram, M.D., Iowa City, Iowa.*

A Further Contribution to the Knowledge of Birth Palsy. B. Valentin. *Ztschr. f. orthop. Chir.*, LI., Heft 1, 1929.

Without pathologic material, the determination of the site of the lesion causing palsy of the shoulder girdle is bound to be uncertain at best. The author does not believe that the majority of cases are the result of a faulty birth mechanism as most observers have taken more or less for granted. He maintains that no one theory will explain all the cases. Injuries to the plexus certainly do not occur in many.

He recounts in detail a case in which a male infant was born without known trauma. The infant did not breathe for some time and resuscitation by swinging was resorted to. Four days after birth the child first began to move the right arm but weakly and the left in similar fashion. The neurological findings were such that a competent neurologist diagnosed a bilateral plexus injury of the seventh cervical and first dorsal vertebrae. Twelve weeks after birth the child died, having evidenced all the time signs of some intracranial disturbance. The only relevant maternal history consisted of three injections of typhoid serum during her pregnancy.

Postmortem revealed no injury of either plexus, but an area of degeneration in the lower cervical and upper dorsal gray matter, two to three centimeters long, corresponding to the seventh and eighth cervical vertebrae. This malacic area contained no old blood or hemosiderin containing cells. Glial proliferation was extreme. Other regions of the cord quite distant from the area showed similar gliosis—as in the nucleus arciformis of the medulla oblongata.

The author is inclined to believe the multiple lesions are possibly of infectious origin as similar changes would occur in typhoid, for example. At the time of death no evidences of old blood were present, yet the possibility of the flexion and extension movements of the vertebral column during resuscitation being at fault cannot be ruled out.

In general, the author feels the traumatic factor in the production of birth palsy has been overestimated, especially in so far as plexus injuries are concerned, and feels the etiology is to be confirmed by pathological check-up if the opinion is to be of any value.—*J. E. Milgram, M.D., Iowa City, Iowa.*

Dauerresultate nach künstlicher Pfannendachbildung (End Results of Artificial Formation of a Roof to the Acetabulum). H. Spitzy. *Zentralbl. f. Chir.*, LV, No. 21, 1282, 1928.

In 1923 Spitzy described a method of treatment for irreducible dislocation of the hip, consisting of formation of a roof to the acetabulum. (Zeitschrift für orthopädische Chirurgie, Vol. XLIII.) The method is as follows: by Hoffa's incision the acetabulum is exposed, after reducing the head of the femur. From the other tibia is taken a peg two centimeters wide and five centimeters long. Then right above the hip joint, without opening it, is formed a hole one centimeter deep and two centimeters wide, and the peg is firmly fixed into that hole. Moreover, in order to give the head secure hold, a thin round peg is driven through the head into the acetabulum. The latter peg was entirely absorbed after a while, whereas the thick peg formed a roof and became thicker and firmer in time and served as a very secure and firm hold for the head. In another case, a long needle was used instead of the thin peg, but in later cases no other hold than the

roof was given for the head. Spitzy has used his method in seven cases with entirely satisfactory end results.—*C. H. Bucholz, M.D., Halle, Germany.*

ZUR OSTEOMYELITIS. Martens and Others. Discussion at the Surgical Society of Berlin. *Zentralbl. f. Chir.*, LV, No. 26, 1617, 1928.

Martens discusses the operative indication in osteomyelitis and points out that the early diagnosis is the most important factor. Martens recommends the primary opening of the bone marrow before a periosteal abscess has formed. He has never seen any damage from the early opening of the bone and rejects Rost's statistics from the surgical clinic in Heidelberg. He drills the bone before opening it.

In the discussion following, Plenz stated that for the operative indication the general condition is of far greater importance than the local findings. The term osteomyelitis should be quite distinctly understood as phlegmon of the bone marrow; with such understanding one would often be led towards primary opening of the bone marrow.

Hinz stated that formerly he usually opened the whole marrow canal, but since he had seen extended necrosis in such cases, he now takes off the outer layer of the bone and then opens a small part. He does not resect the marrow, but allows it to bleed thoroughly and covers it very loosely with gauze or even leaves it uncovered. The inflammation generally recedes very quickly, the temperature becomes normal within one or two days, and within three or four weeks the wound is healed.

Riese and others emphasized that the early pictures are always negative and therefore roentgenograms are of no value for the early diagnosis of osteomyelitis.

Axhausen recalled Helferich's experience. For three succeeding years he primarily opened only the periosteal abscess, whereas in the following three years he primarily opened the marrow space. The results were much better in the first series of cases.

Zeller recalled the research of Hedri, who pointed out that in cases of extensive phlegmon of the marrow, fat is found in the urine and recommended the examination of the urine in all early cases.

Petermann recommended that the incision at the humerus and the femur be made on the outer side, far from the big vessels even in those cases when the abscess threatens to break through on the inner side. He lost a case by erosion of the femoral artery by a sequestrum and believes that such occurrence could be avoided by making the incision on the outer side.—*C. H. Bucholz, Halle, Germany.*

VERSUCHE MIT IMMOBILISATIONSAPPARATEN ZUM BADEN BEI ORTHOPÄDISCHER TUBERKULOSE IN KRALJEVICA (Immobilization of Surgical Tuberculosis during Bath). M. Šarčević. *Abstr. in Zentralbl. f. Chir.*, LV, No. 35, 2224, 1928.

The author is an orthopaedic surgeon in Kraljevica at the Adria. He applies a Bradford frame made of galvanized iron and covered with sailing webbing, with the Thomas' splints, and allows his patients to take baths in the sea for a few minutes at a time. An air and sun bath is added to the salt water bath. Following Codivilla's teaching, Šarčević considers immobilization in different degrees as most important for surgical tuberculosis. The salt water bath is permitted when the milder degree of immobilization has begun.—*C. H. Bucholz, M.D., Halle, Germany.*

ERFAHRUNGEN MIT DER ALBEE'SCHEN OPERATION BEI SPONDYLITIS TUBERCULOSA AN DER ORTHOPÄDISCHEN KLINIK KÖLN (Albee's Operation in Pott's Disease). Surgical Society of Cologne. Orthopaedic Clinic. Cramer. *Zentralbl. f. Chir.*, LV, No. 35, 2198, 1928.

Cramer reports the end results with Albee's operation in Pott's disease. The operation was done in twenty-three cases, all of which had been operated on five to thirteen years before. One child died on the day of the operation; eight died within a few years. In four cases paralysis took place in spite of the operation and three of them died. In only one case a good result was obtained; the acute disease healed within six months after the operation. Cramer believes the operation indicated only in cases where, in spite

of conservative treatment of long duration, the disease shows no tendency to spontaneous recovery. The operation should not be done before the twelfth year.

In the discussion Kroh proposes implantation of a strip of fascia to fix the laminae of the vertebrae in addition to the implantation of Albee's bone peg. The use of foreign materials is refuted.—*C. H. Bucholz, M.D., Halle, Germany.*

Die Angeborene Verenkung des Sprungbeins (The Congenital Dislocation of the Astragalus). K. Deutschländer. Meeting of the Northwestern Surgical Society in Kiel. *Zentralbl. f. Chir.*, LV, No. 45, 2848, 1928.

Deutschländer supposes that the congenital displacement of the astragalus is not rare as he has seen twelve cases during one year. The cases resemble those of severe flat feet but they differ in many respects. The astragalus stands in almost vertical and the os calcis in more or less horizontal position. The scaphoid may be normal or may show distinct changes, but it is always in its normal position and does not take part in the changes leading to the flat-foot appearance. The bony prominence which is usually noted anterior to the internal malleolus is not formed by the scaphoid, but by the neck of the astragalus. The patients often complain of more pain than is usually seen in cases with flat feet of the same age.

Mau in the discussion states that in his clinic (Kiel) those feet are called rocking feet. He has obtained good results with resection of the head and neck of the astragalus followed by manipulation and fixation in plaster-of-Paris for six months. — *C. H. Bucholz, M.D., Halle, Germany.*

Schädigungen des Knochenwackstums durch Röntgerbestrahlung (Damage to the Growth of Bone by Exposure to Roengten Rays). Beck. Meeting of the Northwestern Society of Surgeons in Kiel. *Zentralbl. f. Chir.*, LV, No. 45, 2849, 1928.

Beck reports six cases from the surgical clinic in Kiel where a marked limitation of the growth was noted after repeated exposures to roentgen rays for the treatment of tuberculosis. The treatment was given five to fourteen years previously. In one case the leg was fifteen centimeters shorter, in another the foot was three centimeters shorter and smaller. Beck discusses the question as to whether the damage is done to all cells or to certain kinds only, but he inclines on the whole to the former opinion because of the general change seen in several cases. He admits that at that time the doses were greater than at present, but he is not quite certain but that that form of treatment should be given up altogether. At least it should be given only with the greatest care in cases of growing individuals.—*C. H. Bucholz, M.D., Halle, Germany.*